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MISCELLANEOUS PAPERS

BY

FRED JAY SEAVER

VOLUME I

This volume contains all available reprints of papers published by the writer for 1904–15 inclusive, except the Discomycetes of Eastern Iowa; Iowa Discomycetes; and the Hypocreales of North America, each of which is separately bound. The volume consists of 38 numbers, containing 251 pages of text, 34 plates, and 12 figures.

1905-1915

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No 1:

A NEW SPECIES OF SPHAEROSOMA.

FRED JAY SEAVER.

(Reprinted from the *Journal of Mycology*, 11:2-5. Jan. 1905.)

The genus *Sphærosoma* was first described by Klotzsch about the year 1840 and was then represented by one species, *Sphærosoma fuscescens*, which was described by him at that time, the exact description being given below for the purpose of comparison. Since that time two other species have been reported, *Sphærosoma ostiolatum* Tulasne, *Fungi Hypogaei*, p. 184; and *Sphærosoma fragile* Hesse. *Jahrbuecher fuer Wissenschaftliche Botanik*, published by Pringsheim, pp. 248 to 254.

CLASSIFICATION OF SPHAEROSOMA.

DISCOMYCETES.

Ascomycetous fungi with the hymenium, or fruiting surface, well exposed at maturity.

HELVELLINEÆ.

Receptacle stipitate and more or less clavate or pileate, or sessile and spreading; fleshy, waxy or rarely gelatinous. Hymenium always exposed.

RHIZINACEÆ.

Receptacle fleshy-waxy, brittle, sessile. Hymenium exposed from the first, plane or convex. Asci cylindrical, operculate. Paraphyses numerous, free.

SPHÆROSOMA KLOTZSCH.

Receptacle fleshy, sessile, convolute, roundish, outer surface covered entirely by the hymenium, within sterile. Asci cylindrical. Sporidia spherical, verrucose, hyaline.

SPHÆROSOMA ECHINULATUM Seaver n. sp. Plants gregarious or scattered, occasionally crowded, sessile, 1 to 8 mm. in diameter; at first almost spherical and regular in outline, becoming convolute with age, especially on the upper surface, often umbilicate; lower surface sterile, nearly plane, attached to the soil near the center by delicate hyphæ, very easily detached; at first white or whitish becoming reddish-brown on the exposed surface, then dark brown; the color begins with a brown spot in the center of the upper surface and spreads until it covers all of the exposed surface; at maturity having a brown velvety appearance due to the large, brownish paraphyses which extend far beyond the asci; under-surface light colored; hymenium at maturity covering the exposed surface of the plant, composed of very large asci and paraphyses; asci 40 to 50 by 300 to 500 mic., clavate, 8-spored; sporidia globose, at first smooth, filled with numerous guttulæ, and surrounded with a transparent exospore, gradually becoming rough on the outside, at maturity covered with spines which are several times as long as broad; spines 4 to 5 mic. in length by

2 to 2.5 mic. broad at the base, often bent at their apices, at maturity extending to the outer surface of the exospore; spore, excluding exospore 25 mic. in diameter, including spines or exospore, 35 mic. in diameter; paraphyses large, clavate, septate, brownish, 12 to 15 mic. in diameter at the apex; sterile part of the receptacle composed of rather loosely interwoven hyphæ, grading into pseudo-parenchyma, cells large.

Habitat—On the surface of damp soil between the tufts of grass in an open place, in the margins of woods near Iowa City. Plants collected from June to October.

The specific name under which these plants are described is suggested by the character of the markings of the spores, which are distinctly echinulate.

The description and measurements given above were made from fresh material collected at different times. Specimens preserved in alcohol vary somewhat; the most of the color disappears and the plants are a little contracted and the measurements are therefore a little less.

The plants described above were collected during the later part of the month of June in the summer of 1904, in large numbers in a ravine near Iowa City and upon examination were at once referred to this genus. The individuals are at first almost spherical in form, smooth on the outer surface, and of a whitish or lead color. As they mature, a small, brown spot is formed in the center of the supper surface, the brown color gradually spreading until it covers all of the exposed surface. They are at first regular in outline, becoming, at maturity, irregularly convolute and more or less depressed, so that at maturity the plants are roundish but more or less irregular in form, of a deep brown color and with a soft velvety appearance. Examination of sections of young plants shows the brown spot on the upper surface to be the beginning of the development of the hymenial layer and the brown color and velvety appearance to be due to the large paraphyses which contain brown coloring matter.

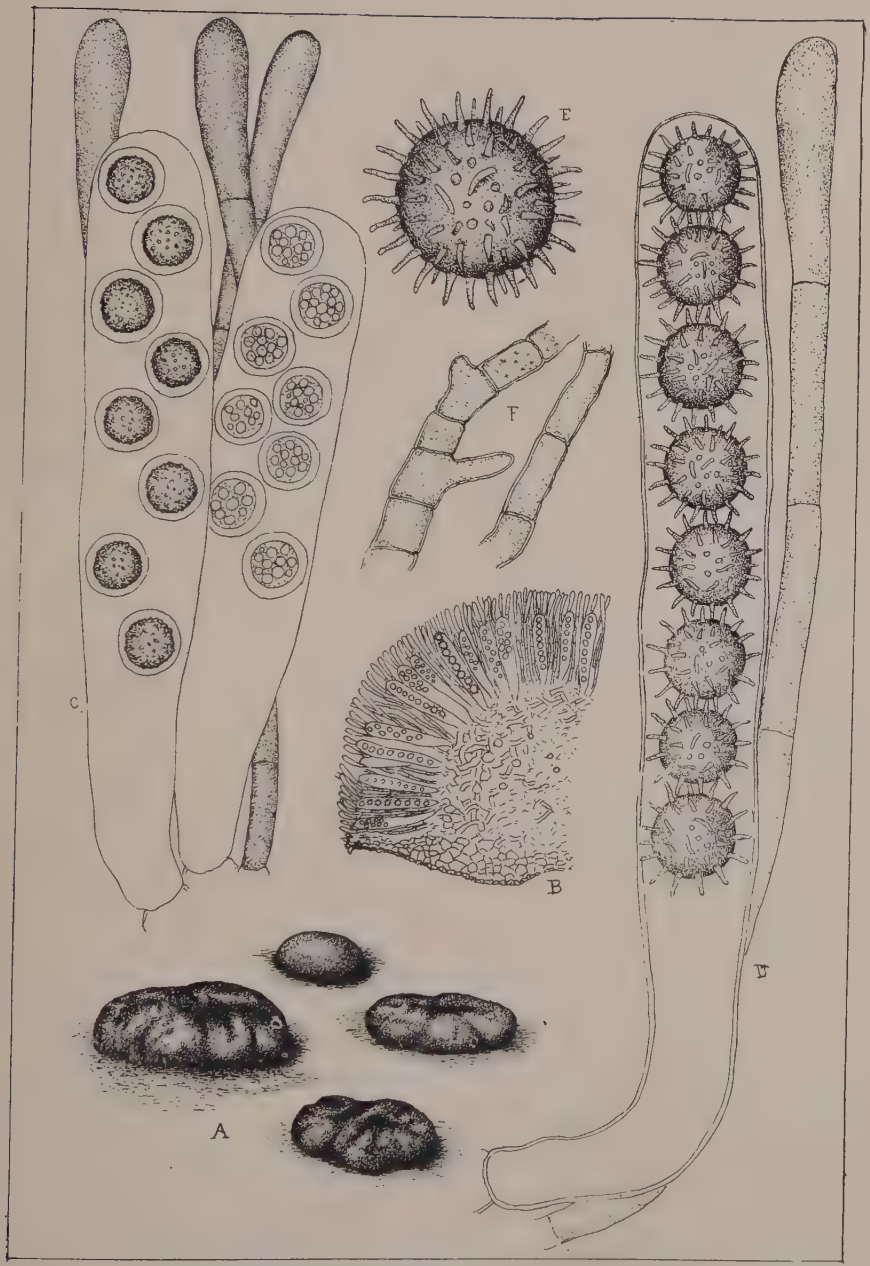
During the early stages of their development, the spores are located near the end of the ascus; they then spread out and become alternately arranged as shown in the diagram and at last are disposed in one row. They are at first smooth and filled with numerous oil drops which disappear as the spore matures and the whole body of the spore is surrounded by a transparent exospore. The first appearance of the roughenings on the outer surface occurs at the periphery of the spore proper within the exospore, the thickenings being at first very slight but gradually increasing until they reach the outer surface of the exospore. When mature a faint line may often be seen near the tips of the spines which is the boundary of the exospore but these become indistinct and in alcoholic specimens and often in mature spores of fresh material the boundary of the exospore is not visible at all, although at

an earlier stage it is very distinct. All gradations may be found between the smooth and echinulate spores, so that they are at first smooth, then verrucose and at last echinulate. The description and drawing of the verrucose markings on the surface of the spores of *Sphærosoma fuscescens* Klotzsch might be explained by the fact that they were studied while immature, but this is not likely to be the case for both mature and immature forms are present in older specimens in the same plant. Microscopic examination shows on the surface in addition to the spines markings which resemble reticulations, but these are short and not continuous and are not seen at the periphery so that they are probably only spines bent so as to give this appearance.

The relative position of the hymenium is shown in cross-section and also the relation of the asci and paraphyses and the structure of the sterile part of the receptacle. The paraphyses are seen to be relatively large and to extend some distance beyond the asci. Beneath the hymenium the interwoven hyphæ give rise to a sort of pseudo-parenchyma which is more definite near the base where the cells are smaller.

Each of the other species described is reported as occurring in woods under leaves and thus showing a tendency to become subterranean species. *Sphærosoma fragile* is described by Hesse as "ein unterirdisch-wachsender Discomycet." The plants described here vary in this respect, being found on the margin of a swampy place on the surface of rather hard, damp soil, in the shade of scattered tufts of grass, in a small ravine in the woods. They are attached to the soil by hyphæ which are so delicate that it is difficult to collect the plants without having them broken from the substratum.

These plants were collected in large numbers over a limited area and are generally more or less scattered but often several are crowded together. They were first found in this locality during the latter part of June but probably appeared much earlier than this. Frequent collections and studies were made in the field from this time until the first of October. The place was next visited in the latter part of September but at this time none of the plants could be found as the ground was covered with other forms of vegetation. Since these plants occur in such large numbers over this limited area it is likely that they will appear in the same locality during the next season, as such has often been found to be the case with other forms of Discomycetes. During the last three seasons, *Sphærospora confusa,* another Discomycete has been collected in abundance on a sandy bank, over an area limited to a few rods in diameter from spring until autumn, but has never been collected in any other locality near Iowa City so far as is known. The same has been found to be true of other species where the habitat is constant. For these reasons these plants will be expected to appear in this locality again.



SPHAEROSOMA ECHINULATUM SEAVER n. sp.

SPHÆROSPORA FUSCESCENS Klotzsch.—Dietrich; Flora Regni Borussici, Vol. VII, No 467 (1839). Receptaculo solido, sphærico, nudo, gibboso, interdum depresso, sessili; basi fibrilloso, primo extus interusque sordide-albido v. pallido-gilvo, dein fuscente; ascis immersis, clavaeformibus, hyalinis; paraphysibus verrucosis, hyalinis.

The present species is distinguished from *Sphærosoma ostiolatum* Tulasne, and *Sphærosoma fragile* Hesse, by its solid receptacle and is then more closely related to *Sphærosoma fuscescens* Klotzsch, the exact description of that species being given above for the purpose of comparison. The general description of the two species seems to be identical, except as to habitat and size of the plants. The characters which distinguish this species from the one described by Klotzsch are the size of the asci and spores and the markings on the surface of the spores. The measurements of the asci of *Sphærosoma fuscescens* as given by Engler-Prantl in "Die Natürlichen Pflanzen-Familien" are from 22 to 26 mic. in diameter and the spores 17 to 20 mic. in diameter, while the asci of the plants described here are 40 to 50 mic. in diameter and the spores 30 to 35 mic. They are also distinguished by the slender spines on the surface of the spores instead of the verrucose markings described by Klotzsch. These markings are very distinct.

In preparing this paper I am indebted to Dr. William Trelease, director of the Missouri Botanical Garden for the use of literature belonging to that institution; to Dr. Farlow of Harvard, Prof. Underwood of Columbia, and to Mr. J. B. Ellis of Newfield, N. J., for suggestions in regard to the distribution of the genus, and to Profs. Macbride and Shimek for kindly aid in preparing the work.

EXPLANATION OF PLATE.

Fig. A, Several plants at different stages in their development, x 5.

Fig. B, Portion of a section of one of the plants showing relation of hymenium, x 50.

Fig. C, Asci and paraphyses, showing two different stages in the development of the spores, x 500.

Fig. D, Mature ascus and spores with paraphysis, x 600.

Fig. E, One spore removed showing the echinulate markings on its surface, x. 1200.

Fig. F, A portion of the mycelium from the soil, x 1000.

No. 2.

AN ANNOTATED LIST OF IOWA DISCOMYCETES

BY FRED JAY SEAVER.

[From the Proceedings of the Iowa Academy of Sciences.]

AN ANNOTATED LIST OF IOWA DISCOMYCETES.

FRED JAY SEAVER.

The Discomycetes include a large and much neglected group of fungi, variable in form and size and of wide distribution. During the last three seasons, a large number of local species have been added to those already reported, and in this paper an attempt has been made to bring together and list the species reported from the state. Those forms described and illustrated in the "Bulletin of Natural History" of the State University of Iowa (Vol. V, No. 4) are repeated here, and those which have not been described and figured will appear in a later edition of the same bulletin.

The list, as it appears here, is only a partial one, a large number of species having been collected which are still unidentified and new ones continually being added. It is hoped to extend this work and make it as complete as possible and any aid from those interested in the way of material will be gratefully received.

A brief note accompanies each species emphasizing some of the prominent characters, special attention being given to habitat and distribution. The name of the collector accompanies each species except where the collection was made by the author.

In preparing this list I am indebted to Profs. T. H. Macbride and B. Shimek for the use of numerous collections in the university herbarium and to Prof. L. H. Pammel, of Ames, for the use of the Holway collection which contained a number of species not collected at Iowa City and several exsiccati of much value.

HELVELLINEÆ.

FAMILY—GEOGLOSSACEÆ.

1. *Spathularia clavata* (Schaeff.) Sacc.

This species is known to but one locality in the northeast part of the state where it is found on the ground in pine woods among decaying needles. Collected by B. Shimek and E. W. D. Holway.

2. *Leotia stipitata* (Bosc.) Schroeter.

Pileus dark æruginous green; stem yellowish. On naked soil in woods. Turkey creek, autumn, 1902. Not uncommon.

3. *Leotia lubrica* (Scop.) Pers.

Pileus golden yellow becoming brownish or greenish; stem same color. In woods on soil among fallen leaves. Common in woods near Iowa City, during the autumn of 1904.

FAMILY—HELVELLACEÆ.

4. *Morchella esculenta* (Linn.) Pers.

Pileus globose or elongated. A common species in open woods. Various collections by T. H. Macbride and B. Shimek. Iowa City.

5. *Morchella conica* Pers.

Pileus conical; ribs longitudinally inclined. Closely related to the preceding. Not uncommon in open woods. Collected by T. H. Macbride and B. Shimek. Iowa City.

6. *Morchella delicosa* Fries.

Similar in form to the preceding but much smaller; stem stout; pits brownish inside; ribs light colored. Collected by S. C. Knupp in the spring of 1904. Iowa City.

7. *Morchella hybrida* (Sow.) Pers.

Stem large; pileus small and only partially united with the stem. Common in woods at the mouth of Turkey creek during the spring of 1897. Collected by B. Shimek.

8. *Helvella lacunosa* Afz.

Plants yellowish or brownish; pileus adnate with the stem. Various collections by T. H. Macbride and B.

Shimek. Iowa City; Winneshiek county, B. Shimek. Not uncommon in woods.

9. *Helvella crispa* (Scop.) Fries.

Plants snow-white; pileus generally free. Rather common on the ground in woods among fallen leaves during the autumn of 1904. Iowa City.

10. *Helvella elastica* Bull.

Stem slender and even. Not uncommon on soil in woods during the summer and autumn. Various collections. Iowa City;—Winneshiek county, B. Shimek.

11. *Helvella macropus* (Pers.) Karst.

Stem slender and generally even; pileus cup-shaped. Sometimes similar to preceding. Rather common on naked soil in woods. Iowa City.

12. *Gyromitra esculenta* Fries.

Pileus large undulated, brownish; stem short. Plants collected by T. H. Macbride. Iowa City. Rare.

FAMILY—RHIZINACEÆ.

13. *Sphærosoma echinulatum* Seaver.

Journal of Mycology 11, pp. 2-5. On damp clay soil. Common during the summer of 1904 in a ravine one mile north of Iowa City. A rare genus.

PEZIZINEÆ.

FAMILY—PYRONEMACEÆ.

14. *Pyronema omphalodes* (Bull.) Fckl.

Plants crowded, forming reddish or salmon-colored masses from one to two inches in diameter in damp places on charcoal and ashes where wood has been recently burned. Very common in wet weather on burnt places. Iowa City. Summer and autumn, 1904.

15. *Pyronema aurantio-rubrum* (Fckl.) Sacc.

Similar to preceding but distinguished by smaller sporidia. Collected on charcoal. Autumn, 1903. Iowa City.

16. *Pyronema melalomum* (Fries) Fckl.

Cups nearly plane, dingy red, 3 to 5 mm. in diameter. Very common on burnt places. Summer and autumn. Various collections, 1903–4. Iowa City.

FAMILY—PEZIZACEÆ.

17. *Sphærospora confusa* (Cooke) Sacc.

Plants nearly plane, brown, clothed with hairs; sporidia globose. Very common on a sandy bank in the woods one mile north of Iowa City. This species has been collected during the last three seasons in one locality where it occurs on naked soil or among moss plants. It is limited to a very small area and has not been collected in any other locality near Iowa City. 1902–4.

18. *Lachnea hemispherica* (Wigg.) Gill.

Cups hemispherical, .5 to 1 inch in diameter, white inside, externally clothed with brown hairs. Common on naked soil in woods. Various collections. Iowa City, 1902–4;—Decorah, Iowa, July 15, 1882, E. W. D. Holway.

19. *Lachnea scutellata* (Linn.) Sacc.

Cups nearly plane, scarlet, .2 to .5 inches in diameter. Very common on decaying wood in moist places, often among moss plants. Various collections. Iowa City, 1903–4.

20. *Lachnea setosa* (Nees) Sacc.

Similar to preceding but plants much smaller, lighter colored, and hairs much longer. Rather common on decaying wood. Often very numerous and gregarious. Various collections. Iowa City, 1902–4;—Winneshiek county, B. Shimek.

21. *Lachnea hirta* (Schum.) Sacc.

Plants brick-red, similar in size and general appearance to *Lachnea scutellata* (L.) S. but darker colored; spores rough instead of smooth as in the two preceding species. Rather common on the ground in wet places. Iowa City, 1902–4;—Pocahontas county. Summer, 1903.

22. *Lachnea melaloma* (A. & S.) Sacc.

Plants small, brownish-black. Found on burnt wood, and the surrounding soil. Iowa City. Autumn, 1903. Not common.

23. *Lachnea abundans* Karst.

Plants small, 1 to 3 mm. in diameter, dull whitish, very much crowded. Common in one locality during the autumn of 1904. On burnt wood and ashes. Iowa City.

24. *Lachnea albo-spadicea* (Grev.) Sacc.

Plants small whitish, hemispherical, becoming nearly plane. On the ground in shady places. Iowa City. Rare.

25. *Lachnea aurantiopsis* (Ellis) Sacc.

Plants about 1 cm. in diameter, yellowish or orange. On mossy logs. Collected by E. W. D. Holway, Decorah, Iowa, November, 1882.

26. *Peziza aurantia* Pers.

Cups large, 1 inch or more in diameter, bright orange-red. Collected in considerable numbers during the autumn of 1903 in a grassy place at the base of an oak stump. Also in shady woods. Iowa City;—Decorah, Iowa, October, 1882, E. W. D. Holway. Not very common.

27. *Peziza rutilans* Fries.

Plants small, 1 cm. in diameter or less, orange-red, externally whitish. Rather common in woods among moss plants. These plants seem to be found always with the same kind of moss (Atrichum ?). Various collections, Iowa City, 1902-4.

28. *Peziza vesiculosa* Bull.

The specimen described in "The Discomycetes of Eastern Iowa" I, p. 39 (reprint) as *Peziza cerea* Sow. is probably *Peziza vesiculosa* Bull. From the description there seems to be little distinction between the two species. The cups are large and often irregular in form and the flesh very brittle. This species has been found to be very common in strawy manure and soil fertilized with such material. Various collections 1902-4. Iowa City;—Decorah, Iowa, June, 1883, E. W. D. Holway.

29. *Peziza repanda* Wahl.

Collected by E. W. D. Holway at Decorah, Iowa, October, 1882. On old logs.

30. *Peziza badia* Pers.

Plants brown, about one inch in diameter. On naked soil in shady places, moist banks, etc. Iowa City. Summer and autumn, 1902-4. Not uncommon.

31. *Peziza brunneo-atra* Desm.

Plants very dark brown. Distinguished from the preceding by the plane disc-shaped receptacle. On the ground in shady places. Summer. Iowa City, 1904. Rare.

32. *Detonia trachycarpa* (Curr.) Sacc.

Plants large, nearly plane, dark brown. Distinguished from the genus Peziza by the globose spores. Plants were abundant during the autumn of 1904 on burnt places. This species and *Lachnea abundans* K. were found in the same locality, a piece of woods in which a large number of trees (*Populus tremuloides*) had been cut and the brush burned at various places a short distance apart. Both of these species were found in abundance on such places.

33. *Humaria Muralis* Quel.

Plants very small, 2 to 3 mm. in diameter, orange-red. Not uncommon in shady places, often on mossy banks by the roadsides. Autumn, 1904. Iowa City.

34. *Humaria tetraspora* (Fckl.) Sacc.

In external appearance resembling the preceding, but distinguished by the 4-spored asci. In damp mossy places. Autumn, 1903-4. Iowa City.

35. *Humaria humosa* (Fr.) Sacc.

Plants small, 2 to 5 mm. in diameter, orange-red. Common in moist places on naked soil and among moss. Autumn, 1903-4. Iowa City.

36. *Humaria leucoloma* (Hedw.) Fries.

Plants orange-red, very small, 1 to 2 mm. in diameter. Among moss in woods. Autumn, 1904. Rather common.

37. *Humaria granulata* (Bull.) Sacc.

Collected at Decorah, Iowa, on cow dung, 1885, E. W. D. Holway.

38. *Barlæa crec'hqueraultii* (Crouan) Sacc.

Plants very small, orange-yellow. Sporidia globose, echinulate. Numerous on clay soil in ravine. Summer, 1904. Iowa City.

39. *Barlæa cinnabarina* (Fckl.) Sacc.

Plants small, orange-red, at maturity, convex. Sporidia delicately reticulated. Rather common in shady places among moss. Summer, 1904. Iowa City.

40. *Barlæa amethystina* (Quel.) Sacc.

Plants very small, purplish, with a delicate light colored margin; sporidia verrucose. In woods among moss. Summer, 1904. Iowa City. Not uncommon.

41. *Geopyxis nebulosa* (Cooke.) Sacc.

Cups about 1 cm. in diameter, brown, stipitate. On rotten wood. Autumn, 1903. Iowa City;—Decorah, Iowa, August 13, 1882, E. W. D. Holway. Not very common.

42. *Macropodia pubida* (B. & C.) Sacc.

Peziza pubida Berkeley and Curtis, Grev. III, p. 153-4.
Macropodia pubida (B. & C.) Saccardo, Sylloge Fung. VIII, p. 159.
Peziza Morgani (Massee), Morgan, Jour. of Myc. 8, No. 64, p. 190.
Exsiccati—Ellis N. A. Fungi, No. 1269; Rabenhorst-Winter, Fungi Europæi, No. 3275; *Peziza morgani*, Morgan's collection; *Peziza pubida*, Holway collection.

In "The Discomycetes of Eastern Iowa" I, p. 43 (reprint), it was suggested that *Peziza morgani* Massee might be identical with *Macropodia pubida* (B. & C.) Sacc. I have since been permitted by the kindness of Mr. Morgan to examine a portion of the type specimen of *Peziza morgani* and I find that this specimen is identical with *Peziza pubida* B. & C. of Ellis N. A. Fung., No. 1269 and also with the material described in this paper and in "The Discomycetes of Eastern Iowa" as *Macropodia pubida* (B. & C.) Sacc.

The specimen in "Rabenhorst-Winter Fungi Europea" No. 3275 is different. The plants are dark brown, only slightly granular on the outside (not velvety as described by Berkeley and Curtis for this species) and contain spores which are elliptical, rough, and only 15 by 8 microns, while in Berkeley's specimen the spores are described as fusiform and from 25 to 37 microns long.

Peziza morgani Massee then is identical with No. 1269 of Ellis N. A. Fungi and both conform to the original description of *Peziza pubida* Berkeley and Curtis as given in Grevillea, III, pp. 153-4. From the descriptions and material examined there seems to be no doubt that *Peziza morgani* Massee is *Peziza pubida* Berkeley and Curtis.

Peziza (*Sarcoscyphæ*) *pubida* B. & C.—Grevillea, III, pp. 153-4.—Cupulis congestis hemisphericis, margine inflexo extus stipiteque brevi velutinis; paraphysibus brunneis; sporidiis fusiformibus granulatis.

On the ground. Alabama, Peters. No. 6075. Cups three-fourths inch across, crowded, hemispherical, with an inflexed margin, velvety externally as well as the short stem; paraphyses brown; sporidia spindle-shaped, granulated, .001-.0015 long. Mycelium densely betulose. Closely related to the last (*P. semitosta*).

This species is not uncommon on naked soil in woods. The plants are easily distinguished from the characters given by Berkeley in his description quoted above. The cups are hemispherical and with a short stem-like base, the stem and outside of the cup being clothed with short, brown hairs, giving it a velvety appearance. The hymenium is dark colored, when dry almost black. One of the most prominent characters of the species is the large, fusiform spores which at maturity are delicately warted. In woods near Turkey creek, July 30, 1903;—Decorah, Iowa, August 25, 1882, E. W. D. Holway.

43. *Acetabula vulgaris* (Fr.) Fckl.

Cups 1 inch or more in diameter, stipitate; stem and outside of cup costate. Collected by T. H. Macbride in woods near Iowa City, May, 1890;—Decorah, Iowa, July, 1885, E. W. D. Holway. Rare.

44. *Acetabula sulcata* (Pers.) Fckl.

Cups large, yellowish or brownish, with a short, thick, costate stem. On naked soil in woods. Unionville, Iowa. Spring, 1904. Rare.

45. *Galactinia succosa* (Berk.) Sacc.

Cups rather large, .5 to 1 inch in diameter, or more; hymenium brownish; externally yellowish; juice thick, golden yellow. Rather common on naked soil in woods. Various collections, 1902-4. Iowa City.

46. *Otidea leporina* (Batsch.) Fckl.

Cups large, brownish, split on one side nearly to the base. In woods, Winneshiek county, B. Shimek.

47. *Otidea ochracea* (Fr.) Sacc.

Cups much smaller than preceding, yellowish. In woods, Winneshiek county, B. Shimek.

FAMILY—ASCOBOLACEÆ.

48. *Lasiobolus equinus* (Mull.) Karst.

Plants very small, orange-red, clothed externally with nonseptate hairs. On cow dung, spring, summer and autumn. Various collections, 1903-5, Iowa City;—Decorah, Iowa, May, 1886, E. W. D. Holway. Very common.

49. *Lasiobolus raripilus* (Phill.) Sacc.

Plants very much crowded, forming a yellowish mass. On cow dung in a ravine. Autumn, 1903, Iowa City. Rare.

50. *Ascophanus microsporus* (B. & Br.) P.

Very minute, yellowish when fresh, black when dry. On cow dung. Spring and summer. Iowa City;—Decorah, Iowa, May, 1886, E. W. D. Holway. Very common.

51. *Ascophanus cinereus* (Crouan) Boud.

Grown on horse dung in culture. Iowa City. Rare.

52. *Ascophanus testaceus* (Moug.) Phill.

Plants small, orange-red. On old cloth, paper, etc. On old rag carpet. Pocahontas, Iowa. Summer, 1903. Rare.

53. *Ascophanus granuliformis* (Cr.) Boud.

On cow dung. Decorah, Iowa, May 25, 1886, E. W. D. Holway.

54. *Ascophanus carneus* (Pers.) Sacc.

On cow dung. Decorah, Iowa, April 25, 1886, E. W. D. Holway.

55. *Ryparobius pelletieri* (Cr.) Sacc.

Plants very small, white, nearly cylindrical; asci 32-spored. On cow dung in moist places. Various collections, Iowa City, 1902-4. Not uncommon.

56. *Ryparobius sexdecimsporus* (Cr.) Sacc.

Plants very small, whitish; asci 16-spored. On cow dung. Various collections, 1903-4. Iowa City. Not uncommon.

57. *Ryparobius crustaceus* (Fckl.) Rehm.

Plants similar in external appearance to preceding but asci 64-spored. On cow dung. Iowa City. Not uncommon.

58. *Ryparobius pachyascus* Rehm.

Very minute; asci large, many-spored. On cow dung. Not common.

59. *Saccobolus kerverni* (Crouan) Boud.

Plants small, golden yellow when fresh, black when dry. On cow dung. Various collections, Iowa City, 1903-4;—Decorah, Iowa, May, 1886, E. W. D. Holway. Common in moist places.

60. *Ascobolus furfuraceus* Pers.

Plants light yellowish, as large as 5 mm. in diameter. On cow dung. Iowa City, 1903-5;—Decorah, Iowa, April 25, 1886, E. W. D. Holway. Spring, summer and autumn. Very common.

61. *Ascobolus immersus* Pers.

Plants very small; asci and sporidia very large. On cow dung, spring and summer. Various collections, Iowa City 1903-4; March, 1905. Not uncommon.

62. *Ascobolus glaber* Pers.

Plants very small; sporidia much smaller than in preceding. Grown in culture. Iowa City. Rare.

63. *Ascobolus atro-fuscus* Phil. & Plow.

Plants as large as 6 mm. in diameter, brownish when fresh, when dry hymenium almost black. One collection was made in October, 1903. During the summer of 1904 this species was found to be very common on burnt places. It is easily distinguished by its habitat, its brownish color, and the purple, verrucose sporidia.

64. *Ascobolus viridis* Curr.

Plants rather small, about 3 mm. in diameter, yellowish brown or greenish. The sporidia are covered with net-like reticulations. On mud flats near the Iowa river. Summer

and autumn, 1904. Iowa City. This species has been found to be very common on rather hard, damp, clay soil.

65. *Ascobolus brunneus* Cooke.

Collected on horse dung. Autumn, 1904. Iowa City. Not common.

FAMILY—HELOTIACEÆ.

66. *Sarcoscypha coccinea* (Jacq.) Cke.

Cups large, generally stipitate; hymenium scarlet. Various collections, 1902-05. Iowa City;—Decorah, Iowa, March, 1879, E. W. D. Holway;—FortDodge, Iowa, 1904, B. Shimek. Very common on half buried sticks in the woods. Late autumn and early spring.

67. *Sarcoscypha occidentalis* (Schw.) Cke.

Cups much smaller than preceding; stem often very long; hymenium scarlet. On decaying sticks in woods. Spring and summer. Various collections, 1903-04. Iowa City;—Decorah, Iowa, August, 1882, E. W. D. Holway. Rather common.

68. *Sarcoscypha floccosa* (Schw.) Cke.

Cups scarlet inside, clothed with long, white, septate hairs externally. On decaying sticks, spring and summer. Various collections, 1903-04. Iowa City;—Decorah, Iowa, August, 1882, E. W. D. Holway. Rather common in woods.

69. *Chlorosplenium æruginosum* (Nyl.) Karst.

Plants small, stipitate, dark, æruginous green. On wood (oak). Distinguished by the green color of the plants and the wood from which they grow. Various collections. Iowa city. T. H. Macbride and B. Shimek;—Decorah, Iowa, August, 1882, E. W. D. Holway.

70. *Chlorosplenium versiforme* (Pers.) Karst.

Plants irregular in form, greenish. On wood. Decorah, Iowa, August, 1882, E. W. D. Holway.

71. *Dasyscypha nivea* (Hedw.) Sacc.

Plants minute, stipitate, clothed externally with a dense covering of white hairs. On decaying wood (oak). Iowa City, 1904. Common.

72. *Dasyscypha pygmæa* (Fr.) Sacc.

Plants small, yellowish, with a long stem; stem often branched. On half buried sticks and roots in damp place. Summer, 1904. Not common.

73. *Trichopeziza tiliæ* (Peck) Sacc.

Plants small, white, clothed externally with a dense covering of white hairs. Abundant on decaying branches of *Tilia americana*. Unionville, Iowa, May, 1904.

74. *Trichopeziza comata* (Schw.) Sacc.

Plants very small, white, similar to preceding in general appearance but smaller. On decaying oak leaves in wet places. Summer, 1904. Iowa City. Not uncommon.

75. *Phialea fructigena* (Bull.) Gill.

Plants small, yellowish, stipitate or nearly sessile. On acorns and hickory nut husks in wet places in woods. Summer and autumn, 1904. Iowa City. Not uncommon, sometimes abundant.

76. *Ciboria pseudotuberosa* Rehm.

Plants stipitate about 1 cm. in diameter. On acorns. Summer, 1904. Iowa City;—Decorah, Iowa, September, 1882, E. W. D. Holway. Not common.

77. *Helotium citrinum* (Hedw.) Fr.

Plants rather large, .5 to 1 cm. in diameter, stipitate or nearly sessile, lemon-yellow. On rotten wood. Various collections. Iowa City, 1902-5. Very common.

78. *Helotium aciculare* (Bull.) Pers.

Plants small, yellowish, shortly stipitate. On decaying leaves of *Populus tremuloides*. Autumn, 1904. Iowa City. Not very common.

79. *Helotium pallescens* (Pers.) Fr.

Plants very small, light yellow. On much decayed wood. Summer, 1904. Iowa City. Not common.

80. *Coryne sarcoides* (Jacq.) Tul.

Plants rather large, irregular in form, purple or reddish, often cæspitose. On rotten wood in moist places. Various collections, 1902-4. Iowa City. Rather common.

FAMILY—MOLLISIACEÆ.

81. *Mollisia dehnii* (Rabenh.) Karst.

Plants small, parasitic on leaves and stems of *Potentilla norvegica*. Pocahontas, Iowa, summer, 1903;—Iowa City, summer, 1904. Not uncommon.

82. *Mollisia polygoni* (Lasch.) Gill.

Plants very small. On decaying stems of Polygonum. Spring and summer. Iowa City. Common.

83. *Mollisia cinerea* (Batsch.) Karst.

Plants rather small, grayish, sessile, margin often irregularly folded. This species seems to be very common and widely distributed. It occurs on various kinds of decaying wood. Various collections, 1904-5. Iowa City;—Decorah, Iowa, June 26, 1882, E. W. D. Holway.

84. *Niptera saliceti* (Rehm.) Sacc.

Plants minute, light colored. This genus is distinguished from the preceding by the septate sporidia. This species was collected on wood which was so much decayed that it was impossible to determine the kind of wood. Summer, 1904. Iowa City. Not common.

85. *Orbilia chrysocoma* (Bull.) Sacc.

Plants very small, sessile, yellowish. On rotten wood. Iowa City;—Decorah, Iowa, August, 1882, E. W. D. Holway. This species is very common in woods.

86. *Orbilia vinosa* (A. & S.) Karst.

Plants small, similar to preceding but red instead of yellow. On rotten wood. Iowa City, 1904. Common.

FAMILY—PATELLARIACEÆ.

87. *Karschia lignyota* (Fr.) Sacc.

Plants small, black; hymenium nearly plane; sporidia 1-septate, brownish. On decorticated wood. Autumn, 1902 Iowa City. Not common.

88. *Patellaria melaxantha* Fries.

Plants very small, yellowish, gregarious, often confluent; sporidia several septate. On wood. Iowa City. Rare.

89. *Patellaria clavispora* (Peck) Sacc.

Plants very small, black, when dry hysterioform, elongated, when wet becoming more or less expanded, older specimens often circular in outline; sporidia clavate, 3 to 4-septate, brownish. This species has been found to be very common on decorticated willow and often on the bark. The plants, especially when young, resemble those of the genus Hysterium but when mature resemble more closely those of the genus Patellaria. Various collections, 1902–5. Iowa City. Very common on willow.

90. *Lecanidion atratum* (Hedw.) Rabenh.

Plants small, black; hymenium nearly plane; sporidia hyaline, 7 to 10-septate; paraphyses bluish. On decorticated wood. Autumn, 1904. Iowa City. Rather common.

91. *Lecanidion tetraspora* M. & M.

Patellaria tetraspora, Journal of Mycology 8, p. 180. Very closely related to the preceding but asci 4-spored and more cylindrical. Plants very small, black in mass, gregarious. On decorticated wood (ash ?). Autumn, 1904. Iowa City. Rather common.

92. *Blytridium fenestratum* (C. & P.) Sacc.

Plants small, black, circular in outline; hymenium almost plane; sporidia muriform. On poplar branches. Decorah, Iowa, August, 1882, E. W. D. Holway.

FAMILY—CENANGIACEÆ.

93. *Cenangium populueum* (Pers.) Rehm.

Plants breaking through the epidermis, cæspitose, brownish, 5 mm. to 2 cm. in diameter. On dead branches of *Populus tremuloides* and *P. grandidentata*. Howard county. B. Shimek;—Iowa City, April 13, 1905. Very abundant and common.

94. *Cenangium rubiginosum* (Fr.) Sacc.

On dead limbs of *Carpinus americana*. Decorah, Iowa, E. W. D. Holway.

95. *Dermatea cerasi* (Pers.) Fr.

Plants small, light colored externally; hymenium dark. On rotten wood. Iowa City. Rare.

96. *Bulgaria inquinans* (Pers.) Fr.

Plants cæspitose, substipitate, black or brownish-black. Various collections, 1902–4. Iowa City. Very common on bark of oak.

97. *Bulgaria rufa* Schw.

Cups large, cæspitose, externally dark brownish; hymenium light colored, slightly reddish. On dead limbs. Iowa City. Rather common.

98. *Holwaya ophiobolus* (Ellis) Sacc.

Similar in external appearance to *Bulgaria inquinans* but smaller; sporidia very long and slender and multiseptate. On wood. Decorah, Iowa, E. W. D. Holway.

99. *Urnula craterium* (Schw.) Fr.

Plants very large, long stipitate, urn-shaped, blackish. On half buried branches. Various collections, 1902-5. Iowa City. Very common and abundant.

HYSTERINEÆ.

This order includes a large number of plants which are intermediate between the *Discomycetes* and the *Pyrenomycetes*. By some authors they are included with the former and by others with the latter group. The plants of this group are elliptical or elongated in form, generally black in color and rather hard. They open at maturity with a long slit-like aperture, the lips sometimes spreading apart and sometimes remaining tightly closed. A few of the forms collected are included here.

FAMILY—HYSTERIACEÆ.

100. *Glonium stellatum* Muhl.

Perithecia stellately arranged, very abundant; sporidia long, hyaline, 1-septate. On rotten wood. Collected by T. H. Macbride. Iowa City.

101. *Hysterium pulicare* Pers.

Perithecia gregarious, small; sporidia 3-septate brownish. On bark of different trees. Collected by T. H. Macbride. Iowa City. Rather common.

102. *Hysterographium mori* (Schw.) Ellis.

Perithecia gregarious or crowded; sporidia 3 to 5-septate and muriform, constricted in the middle. On decorticated wood (oak and sumach). Iowa City. Very common.

103. *Hysterographium fraxini* (Pers.) Ellis.

Perithecia scattered or gregarious; sporidia large, muriform, and 7 to 9-septate. On dead limbs of ash. Decorah, Iowa, E. W. D. Holway.

104. *Hysterographium cinerascens* Schw.

Perithecia gregarious or crowded; sporidia 6 to 8-septate muriform and constricted in the middle. On decorticated wood (butternut). Iowa City, 1904.

This species seems to conform to the description of *H. cinerascens* and is included under this name here. The plants are quite abundant on old butternut wood.

No 3.

NOTES ON THE DISCOMYCETE FLORA OF IOWA.

BY FRED JAY SEAVER.

The following is a list of a number of species of Discomycetes (including Hysterineae) collected during the last year, which have not been reported in previous papers, also a few notes on other species. This paper is a continuation of the one published in the last volume of the Proceedings of the Iowa Academy of Science, and the number preceding each description is the herbarium number of the species described.

Sphaerosoma echinulatum Seaver was described in the Journal of Mycology from material collected near Iowa City in June, 1904. In June, 1905, the same species was collected in Germany, issued by Dr. Rehm in his Ascomycetes, No. 1601, and described in Annales Mycologici, 3: 409. A specimen of the German material has been examined by the author and as stated by Dr. Rehm in his description the German specimen corresponds almost exactly with the American except for a few slight differences in measurements of spores, asci, etc. The long spines on the outer surface of the spores which is characteristic of the species are common alike to the American and foreign specimens. That this species should occur in two such widely separated localities is interesting.

105. *Trichopeziza sulphurea* (Pers.) Fckl. Plants small, about 1 mm. in diameter, gregarious, sessile, hemispherical, clothed externally with a dense covering of delicate hairs which are filled with yellow coloring matter so that the whole plant when fresh has a sulphur-yellow color, color fading in dried specimens; hairs variable in length, as long as 75 mic., 8-spored; sporidia fusiform, nearly straight or curved, with several near their ends, blunt; hymenium concave, whitish; asci 65 to 75 by 6 mic., 8-spored; speridia fusiform, nearly straight or curved, with several guttulae, 16 to 20 by 2 mic.; paraphyses 2 to 4 mic. broad at their spices.

On dead stems of herbaceous plants. August, 1905. Mt. Pleasant, Iowa. Two collections were made both in the same locality.

106. *Mollisia atrata* (Pers.) Fckl. Plants gregarious, at first nearly rounded, becoming expanded, externally black, hymenium concave, cinerous, often quite dark; asci about 25 by 5 to 6 mic.; sporidia 5 to 6 by 2 mic.; paraphyses slender.

On dead herbaceous stems (*Ambrosia trifida*) August 3, 1905. Mt. Pleasant, Iowa.

The plants described here under this name are larger than is usually indicated for this species but other characters seem to conform closely.

107. *Ciboria sulphurella* (E. & E.) Plants gregarious, stipitate; stem variable in length, sometimes as much as an inch long and slender, but often very short; cup 2 to 5 mm. in diameter, a little concave; plants very

variable in color, often sulphur-yellow when fresh with a tinge of green; hymenium sometimes becoming reddish or reddish-brown, when dry almost black; sporidia elliptical, narrowed at the ends, 10 to 12 by 3 to 4 mic.; asci about 75 by 8 mic.

On petioles of ash and hickory. Autumn, 1905, Mt. Pleasant, Iowa.

This species has been found to be very common during the last season from summer to autumn in moist places on petioles of leaves which are partly buried. The length of the stem varies according to the depth at which the petioles are buried.

108. *Durella clavispora* (B. & Br.) The speicmens included in the herbarium of the author under this number are probably *Lecanidion atratum* (Hedw.). The latter species is very common and up to date has been collected by the author on fifteen different kinds of wood, bark, and herbaceous stems. The two species are closely related.

109. *Morchella crassipes* Pers. Plants large, pileus yellowish-brown, pits large and irregular; asci 8-spored; sporidia 20 to 23 by 10 to 12 mic.; stem large, often nearly as thick as the pileus and rather irregular.

In grassy place, Iowa City, Iowa. May, 1905.

110. *Phialea scutula* (Pers.) Gill. Plants small, 1 mm. in diameter or less, stipitate, stem about 1 mm. long, slender, plants yellowish, hymenium concave; sporidia 18 to 22 mic. long, clavate or nearly so, 2 to 3-guttulate and sometimes apparently 1-septate.

On *Polygonum* stems in wet places. Summer, 1905. Mt. Pleasant, Iowa.

111. *Propolis faginea* (Schrader) Karsten. Plants at first buried in the substratum finally breaking through, hymenium becoming exposed in elongated white patches, often several mm. in length and usually somewhat narrower, broken epidermis forming a rough margin; asci 8-spored, 100 by 12 mic.; sporidia elongated, rounded at the ends, straight or curved with 1 to 3 guttulae (usually 2) about 25 by 8 mic.; paraphyses slender.

On old wood of Sycamore (*Platanus occidentalis*), grape vine (*Vitis-vulpina*), blue beech (*Carpinus caroliniana*) Mt. Pleasant, Iowa. January, 1906.

112. *Phaeopezia fuscocarpa* (Ell. & Hol.) Cups sessile, becoming nearly plane, externally yellowish-green, hymenium dark greenish becoming almost black, 5 mm. or less in diameter; sporidia 2-guttulate, greenish becoming brown, 7 to 8 by 3 to 4 mic.

On old wood. Mt. Pleasant, Iowa. Summer and autumn, 1905.

113. *Patellaria* (*Mycolecidea*) *triseptata* (Karst.). Plants sessile, about 1 mm. in diameter or less, round, at first concave becoming plane, black; asci about 50 by 12 to 14 mic., 8-spored; sporidia mostly in 2 rows, when mature brownish, 3-septate, a little constricted at the septa, 15 to 17 by 5 mic., often slightly curved; paraphyses slender, branched, forming a brownish epithecium.

On old wood. Mt. Pleasant, Iowa. Autumn, 1905.

114. *Sclerotinia seaveri* Rehm. Ann. Mycol. 4: 66. Cups 2 to 5 mm. in diameter, concave or nearly plane with a depression in the center, supported on a long stem, length of stem varying according to the depth at

which the substratum is buried under leaves and soil, plants dull yellowish-brown; asci 100 to 120 by 10 mic.; spores in 1 row, elliptical, about 12 by 5 mic.; paraphyses enlarged upwards.

On buried seeds of wild cherry (*Prunus serotina*) April, 1905. Iowa City, Iowa.

In the spring of 1905, Prof. B. Shimek brought into the laboratory at Iowa City, a number of discomycetes growing from the seeds of wild cherry. Prompted by this observation, the author afterwards made a large collection of this same species on cherry seeds which had become buried under leaves and soil in damp places. The species was observed and collected in several localities near Iowa City. During the following summer a specimen of this material was sent to Dr. Rehm, with other specimens, who described it as a new species under the name given above.

During this month (April 16, 1906) a specimen of *Sclerotinia* was collected by the author near Mt. Pleasant which corresponds very well with the material from which Dr. Rehm described this species in size, general appearance, spore measurements, etc. of the plants, but growing on the seeds of bass wood (*Tilia americana*). It may be that the two are the same species. The species is issued in Rehm's Ascomycetes, No. 1633.

115. *Helotium citrinulum seaveri* Rehm. Ann Mycol 4: 67. Plants very small, about 1 mm. in diameter or less, externally whitish; hymenium lemon yellow, nearly plane; asci 35 to 45 by 5 to 6 mic.; sporidia straight or curved, fusiform, 7 to 8 by 2 mic.; paraphyses slender, about 1 mic. in diameter.

On dead stems of *Carex* sp. on hillsides, Iowa City, Iowa, May, 1905.

Two collections of this species were made at Iowa City in localities about two miles apart. The plants are small and not easily seen but were found in considerable numbers after some search on the dead stocks surrounding the living bunches of *Carex*.

Issued in Rehm's Ascomycetes, No. 1634.

116. *Gloniella ovata* (Cke.). Perithecia small, about 1 mm. in length or less, black, lips mostly tightly closed; sporidia inclined to fusiform but with ends rounded, one end smaller, 3-septate, constricted at the middle septum and slightly at the end septa 14 to 16 by 6 by 7 mic.

On old wood. July 25, 1905. Mt. Pleasant, Iowa.

This was thought to be a *Glonium* as many of the spores at first appear to be 1-septate, but on closer examination they are found to be 3-septate and hyaline.

117. *Glonium parvulum* (Ger.) Perithecia closely gregarious, small, not more than 1 mm. in length, black, lips closed; asci about 50 by 5 to 6 mic., sporidia hyaline, 1-septate, strongly constricted at the septum, about 7 to 8 by 4 mic.

On old wood oak and sycamore (*Platanus occidentalis*). Winter 1906. Mt. Pleasant, Iowa.

118. *Coryne urnalis* (Nyl.) Sacc. Cups rather large, nearly an inch in diameter, reddish-brown, hymenium at first concave, becoming nearly plane; sporidia fusiform, 24 to 25 mic. in length, with several delicate septa, often slightly curved.

On partly decayed wood. November 13, 1905. Mt. Pleasant, Iowa.

This species is closely related to *Coryne sarcoides* (Jacq.) but is distinguished by the larger size of the plants and spores. The two species seem to grade into each other.

119. *Barlaea miniata* Crouan. Plants small, 2 to 5 mm. in diameter, at first concave then nearly plane, orange-red; asci long, 150 by 16 to 18 mic.; sporidia globose, with 1 large guttula, epispore delicately reticulated, reticulations regular, 15 mic. in diameter; paraphyses slender, enlarged upwards, filled with orange granules.

On rather sandy soil, among moss. Iowa City, Iowa. May 22, 1905.

120. *Hysteropatella prostii* (Duby) Rehm. Plants small, 1 mm. in length or less, black lips spreading, asci about 50 by 10 mic.; sporidia slightly curved, brownish, 3-septate, about 15 by 4 mic.

On old bark (elm?). May 5, 1905. Iowa City, Iowa.

121. *Hysteropatella elliptica* (Fr.) Rehm. Plants scattered or collected in little groups, rather larger than the preceding, black, lips spreading sporidia straight or slightly curved, 3-septate, brownish, 23 by 8 mic.

On old bark (crab apple?). August 1905. Mt. Pleasant, Iowa.

This and the preceding species are rather closely related. The two have been included with the pyrenomycetes but belong more properly with the discomycetes.

No 4.

ASCOMYCETES AND LOWER FUNGI.

GUY WEST WILSON AND FRED. JAY SEAVER.

Reprinted from the *Journal of Mycology*, 13: 48-52, March, 1907.

ASCOMYCETES AND LOWER FUNGI.

GUY WEST WILSON AND FRED. JAY SEAVER.

It is the intention of the writers to issue, as material accumulates, exsiccati of fungi under the above title, the scope of the work being limited to Ascomycetes, Deuteromycetes and Phycomycetes. This material will be issued in unbound fascicles of twenty-five numbers each. The following is an annotated list of the contents of the first fascicle:

1. CHLOROSPLENIUM CHLORA (Schw.) Massee.

Peziza chlora Schweinitz, Syn. Fung. Car. Sup., 96. 1822.

Chlorosplenium schweinitzii Fries, Summa Veg. Scand., 356. 1849.

Chlorosplenium chlora (Schw.) Massee, Jour. Linn. Soc., 35:116. 1901.

Plants externally bright yellow; hymenium dull becoming green. The genus *Chlorosplenium* was founded by Fries on *C. schweinitzii* which is synonymous with this species.

2. DERMATEA OLIVASCENS Rehm, Ascomycetes, 1686.

The material issued under this number is a part of the type collection. The species is close to *Dermatea crataegicola* Durand. On branches of *Crataegus* sp. apparently dead but still on the tree.

3. Diaporthe parasitica Murrill, Torreya 6:189. f. 2. 1906.

This is the only parasitic species of the genus. It is rapidly destroying the Chestnut trees, both old and young, in the infested region which is known to extend as far south as Virginia and probably farther.

4. Fumago vagens Pers. Myc. Eur. 1:9. 1822.

On leaves of *Quercus* sp.

5. Gloniopsis smilacis (Schw.) n. n.

Hysterium smilacis Schweinitz Syn. Fung. Car. Sup., 23. 1822.
Hypoderma smilacis (Schw.) Sacc., Syll. Fung. 2:789. 1883.
Hysterographium smilacis (Schw.) Ellis & Everhart, N. Am. Pyrenom. 709. 1892.

Common on dead stems of *Smilax*.

6. Glonium stellatum Muhlenberg; Schw. Syn. Fung. Car. 24. 1822.

Specimens issued were abundant on old butternut wood.

7. Gloesporium venetum Speg., Michelia 1:477. 1879.
Gloesporium necator Ellis & Everhart, Jour. Myc. 3:129. 1887.

The first report of this species in America was from Illinois. It has later been reported from almost the entire region in which the raspberry is cultivated. While usually not considered destructive, it is locally a serious pest.

8. Hendersonia staphyleae Ellis & Everhart, Jour. Myc. 1:151. 1885.

This species occurs on the young, dead twigs of *Staphylea trifoliata*. During the spring of 1907 it was found to be common.

9. Hypoderma commune (Fries) Duby.

Hysterium commune Fries, Syst. Myc. 2:589. 1823.
Hypoderma commune Duby, Mem. Soc. Phys. Hist. Geneva, 16:41. 1861.

The plants of this species form elongated smooth, shining patches on the stems of herbaceous plants. The lips usually remain tightly closed but often spread so as to show the lighter colored disc.

10. HYPOXYLON SASSAFRAS (Schw.) Berkeley.

Sphaeria sassafras Schweinitz, Syn. Fung. Car. Sup. 10. 1822.

Hypoxylon sassafras Berkeley, Grevillea, 4:52. 1875.

The perithecia are large and either single or confluent. On dead branches of *Sassafras*.

11. HYSTEROGRAPHIUM MORI (Schw.) Rehm.

Hysterium mori Schweintiz, Syn. Fung. Am. Bor. 244. 1832.

Hysterographium mori (Schw.) Rehm. Ascomycetes 363. 1877.

This is a very common and variable species. The specimens issued here occur on decorticated wood of *Gleditschia*. The plants are often very thickly crowded and mostly parallel with the grain of the wood.

12. HYSTEROPATELLA PROSTII (Duby) Rehm.

Hysterium prostii Duby, Bot. Gall, 2:79. 1830.

Hysteropatella prostii (Duby) Rehm. Rabenh., Krypt-Flora, 1^3:367. (Ed. 2.) 1896.

Plants usually scattered and with the lips widely gaping. The plants occur on either side of the young fallen bark of (elm?).

13. MELASMIA GLEDITSCHIAE Ellis & Everhart, Jour. Myc., 4:45. 1888.

Leptrostroma hypophylla Berk. & Rav., Ravenel, Fungi Carol. Exs. 3:45. 1855.

Melasmia hypophylla P. Sydow, in Sacc. Syll. Fung. 10:419. 1892.

On leaves of Gleditschia triacanthos.

14. MICROSPHAERA SYMPHORICARPI E. C. Howe, Bull. Torrey Club, 5:3. 1874.

Salmon considers this as a form of *M. diffusa* Cooke & Peck, but American mycologists have usually accorded specific rank to both.

15. MOLLISIA DEHNII (Rabenh.) Karsten.

Peziza dehnii Rabenhorst, Bot. Zeitung, 1:12. 1843.

Mollisia dehnii (Rabenh.) Karsten, Myc. Fenn. 1:206. 1871.

Plants occur in abundance on the stems and leaves of *Potentilla norvegica* and related species.

16. Nectria peziza (Tode) Fries.

Sphaeria peziza Tode, Fungi Meckl. Sel. 2:46. 1791.
Nectria peziza (Tode) Fries, Summa Veg. Scand. 388. 1849.

Plants bright orange-red, soft, nearly globose, collapsing from above so as to become cup-shaped and very closely resembling a cup-fungus. Rather common but usually not abundant on old rotten wood and occasionally on bark.

17. Nectria purpurea (Linn.) n. n.

Tremella purpurea Linn. Sp. Plant., 2:1158. 1753.
Tubercularia vulgaris Tode, Fungi Meckl., 1:18. 1790.
Sphaeria cinnabarina Tode, Fungi Meckl., 2.9. 1791.
Nectria cinnabarina (Tode) Fries, Summa Veg. Scand., 388. 1849.

One of the most common and variable species of the order *Hypocreales*. On branches of various kinds of trees and shrubs.

18. Peronospora corydalis de Bary, Ann. Sci. Nat., IV, 20:111. 1863.

Both *Bicuculla canadensis* and *B. cucullata* were growing together in the ravine where this material was collected but careful search failed to locate a single infected plant of the latter species.

19. Phyllosticta fraxinicola (Curr.) Sacc. Syll. Fung., 3:21. 1884.

Sphaeria (Depazea) *fraxinicola* Currey, Trans. Linn. Soc., 22:333. 1857.
Phyllosticta fraxini Ellis & Martin, Am. Nat., 18:189. 1884.
Phyllosticta fraxinicola (Curr.) Sacc. Syll. Fung. 3:21. 1884.

The infected spots are very variable in color, usually with a pronounced reddish margin, but frequently grading imperceptably into the healthy green portions of the leaf. All intermediate variations occur.

20. Phyllosticta liriodendri Thüm., Jour. Sci. Math. Phys. Nat., 1878.

Phyllosticta liriodendri Cooke, Grevillea, 12:26. 1883.
Phyllosticta liriodendrica Cooke; Sacc. Syll. Fung. 3:30. 1884.
Phyllosticta circumvallata Winter, Jour. Myc., 1:123. 1885.

Phyllosticta tulipifera Passer. Real. Acad. Linecei Rend, 4. 1888.

The names cited in the synonymy of this species are all based on material collected from the same host in different countries. The first came from Portugal, the second from South Carolina, the third is merely a renaming of the second, the fourth is from Missouri, and the last from Italy. The only points of difference which are emphasized by the descriptions are the size of the spots, the color of their margin, and such minor discrepancies in spore measurements as are to be expected. The gross characters are too variable to be of primary taxonomic value, while the spore measurements of these descriptions present less variation than is found in a single collection of material in quantity.

21. PHYLLOSTICTA SASSAFRAS Cooke, Grevillea, 12:26. 1883.

This species was originally described from material collected in South Carolina by Ravenel and sent to Cooke for identification and distribution. In their paper on the genus Ellis & Everhart say of this species: "All the specimens are sterile and the species must be considered doubtful" (N. Am. Phyllostictas 44). The present material contains an abundance of very minute spores which conform well to the original measurements.

22. RHYTISMA ANDROMEDAE-LIGUSTRINAE (Schw.) n. n.

Xyloma andromedae-ligustrinae Schw. Syn. Fung. Car. 26. 1822.

Rhytisma decolorans Fries, Syst. Myc., 2:567. 1822.

This is a very poorly understood species which is probably more closely related to *Discomycopsis rhytismoides* J. Müll. than to the species with which it is usually associated.

23. ROSELLINIA AQUILA (Fries) de Notaris.

Sphaeria aquila Fries, Syst. Myc., 2:442. 1828.

Rosellinia aquila (Fries) de Notaris, Sferiacei Ital. 1:21. 1863.

Perithecia large, seated in a byssoid stroma. On dead branches.

24. SPHAEROPSIS ALNICOLA Peck. Ann. Rep. N. Y. St. Mus. Nat. Hist. 38:95. 1885.

The material agrees in gross appearance and spore characters with the present species and differs from *S. betulae* Cooke in its much smaller spores.

25. VERMICULARIA PETIOLICOLA Brun., Ann. Soc. Sci. Nat. Inf. 26:39. 1890.

The present collection of material is slightly darker than the description calls for but otherwise it agrees well.

No 5.

COLOR VARIATION IN SOME OF THE FUNGI

FRED JAY SEAVER

Compliments of F. J. Seaver.

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Color variation in some of the fungi

Fred Jay Seaver

The present short paper is the outgrowth of a year spent at the New York Botanical Garden as Columbia University fellow in botany, during which a large amount of time was spent in the study of the North American Hypocreales, the main results of which are still unpublished. The order Hypocreales belongs to the group of fungi commonly known as the Pyrenomycetes and is distinguished from the other orders of the group by the absence of black color. Instead of the black charcoal-like appearance the plants of the order show almost every conceivable shade, the individuals as a whole probably being more brilliantly colored than those of any other group of fungi and doubtless rivaling, in this respect, any other group of plants. But notwithstanding their brilliant colors, many of the plants of the order are so small and occur in such unexpected places that they escape the eye of the casual observer and often that of the more trained collector as well.

Probably no character is of more importance, if properly used, in the determination of species among the fungi than that of color, and at the same time no character has been so sadly misused. More synonyms in the present order owe their origin to lack of knowledge of the amount of variation of color in the various species of the order than to any other one fact. To describe a new species of maple which is distinguished from some of the species already described by the fact that the leaves are red instead of green would be considered absurd by students of higher plants, yet many species of fungi have been "made" on characters which are just as striking and also just as valueless as the one just suggested. The few corrections which are set forth here are made, not in the spirit of criticism, but with the hope that they may prevent some of the similar errors which otherwise might occur in the future. It is much more difficult to study the life-history of plants which are but a fraction of a millimeter in diameter than that of the higher plants which stand often many meters in height. Yet, if the existence of

these minute organisms is worthy of record at all, as the true lover of science will admit they are, they should deserve just as careful study through all the phases of their life history as do the higher plants, which on account of their large size force themselves upon our attention.

One of the first observations of color variation to come under the eye of the writer was in connection with the study of *Nectria purpurea* (L.) W. & S. (Jour. Myc. **13**: 51), which is more commonly known under the name *Nectria cinnabarina* (Tode) Fries. While collecting in the vicinity of Mt. Pleasant, Iowa, on November 10, 1905, a brush pile was found to be almost entirely covered with the plants of this species, which showed the characteristic cinnabar-red color and a collection of the material was made at this time. A few months later the same spot was visited again with the hope of making a second collection of the same species. The old plants still persisted but were so changed in color as to be scarcely recognizable, the perithecia having become very dark brown and in some cases entirely black. A second collection was made at this time and when compared with the first showed such a marked difference that, were color alone considered, they would constitute two well-defined species. Yet, these two specimens were known to represent the same species collected at different times. A careful study of this species in the laboratory and field has shown the range of coloration to be from bright cinnabar-red when collected in good condition to dull red, light brown, dark brown and finally black, with an infinite number of intermediate shades, the change coming about through weathering and varying conditions of moisture. The originally bright color of the plants and their xerophytic nature, which enables them to persist for a long time, often several months, after maturity, are sufficient to explain the cause of these variations.

In working over the various species of the genus *Nectria* preparatory to a monograph, several species which had been recorded in previous North American monographs had been tabulated in the notes of the writer as "suspicious characters" on the ground that the descriptions were too brief and indefinite to give any conception as to the real nature of the specimens described and in most cases gave no character which could be considered as dis-

tinctive of the species except color, which in this genus is very uncertain. Several of the species belonging to the doubtful list were from the notorious "B. & C." collections. In every case an attempt has been made to gain access to the type specimen of such species. Through the authorities of the New York Botanical Garden we have succeeded in securing several cotype specimens from the Royal Botanic Gardens at Kew and here it might be well to acknowledge the liberality and promptness with which such requests were granted by those in charge of the Botanic Gardens of England. Where specimens were too fragmentary to divide, pencil sketches were carefully prepared which have aided much in shedding light on some of the mysteries surrounding the group under consideration, although drawings do little to clear up the color question.

Some of the doubtful species of which the cotypes have been examined are *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., and *Nectria nigrescens* Cooke. The first two were originally described in the following manner (Grevillea **4**: 45): "Cespitose, red inclined to brown, finally collapsing; spores cymbiform, 1-septate, 15 to 20 mic. long," and "Cespitose, dingy red-brown, minutely granulated, ostiolum depressed; asci clavate; spores 2-seriate oblong, 4 times as long as broad." In neither of these descriptions is there a single character mentioned which would distinguish the supposed species from *Nectria purpurea* (L.) W. & S., when the range of coloration of this species is taken into consideration, and a careful examination of the cotype specimens of each of these species also fails to reveal any valid specific character. The third of these doubtful species is described (Grevillea **7**: 50) as follows: "Cespitose, red, at length turning black, smooth, ostiolum papilliform; asci cylindrical, spores elongated-elliptical, 1-septate, 18 by 6 mic.; stylospores on the same stroma, some ovate brown (5 by 3 mic.), others linear (6 by 2 mic.), hyaline." The only character in this description which might mark a new species is the presence of the brown stylospores and there is no evidence given that these are connected with this plant even though present on the same stroma. Examination of a specimen of this species from Kew shows unmistakable evidence of age and partial decay. The perithecia are blackened and in many cases crumbled and it is dif-

ficult to find asci and spores, all of which are indications of the age of the specimens at the time of collection. The brown stylospores mentioned in the description were not seen and even though present, as suggested above, there is no evidence that they form a part of the life-history of the plant with which they are found. The specimen has every appearance of being a discolored specimen of *Nectria purpurea* (L.) W. & S.

Nectria Meliae Earle (Bull. Torrey Club **25**: 364) is said in the original description to be distinguished from *Nectria purpurea* (L.) W. & S. by the darker color of the perithecia and a slight variation in size. Examination of specimens of this species in the herbarium of the New York Botanical Garden shows no grounds for its separation.

No species deserves more careful study than the one now under consideration for the reasons that it is common and widely distributed, occurs on nearly every kind of tree and shrub, and, being a persistent form, shows much variation in color as well as in other characters which would naturally be affected with age. A large number of the closely related so-called species which have been described are distinguished primarily on color and if every shade of color be accepted as a valid specific character we might have an infinite number of "printer's ink" species created from the one form as set apart by nature.

Another case of color variation has been noted in *Hypocrea gelatinosa* (Tode) Fries (Fung. Meckl. Sel. **2**: 46. *f. 123, 124*). Specimens of this species collected by the writer show the very young plants to be of a bright lemon-yellow color, but as the spores mature they become olive-green, giving to the stroma a mottled appearance. The whole stroma then becomes darker until it assumes a dirty green, finally becoming nearly black with age. In fresh specimens all of these variations have been seen on the same substratum and the relation can be traced from one to the other.

Hypocrea chlorospora B. & C. (Grevillea **4**: 14) is characterized as being distinguished from the above by the black stroma, the color of the spores being the same in both species. While no authentic specimen of this species could be secured, it seems very doubtful if it is distinct from *Hypocrea gelatinosa* (Tode) Fries.

In the Ellis collection at the New York Botanical Garden is a specimen of green-spored *Hypocrea* labeled, evidently in the handwriting of Mr. Ellis, "*Hypocrea viridis* n. s." and the stroma described as being dull greenish within and without, and a note is added stating that it could not be *Hypocrea chlorospora* B. & C. for the reason that that species was characterized by a black stroma. Another note, added, apparently, at some later time, stated that as the plant dried it became darker and might after all be *Hypocrea chlorospora* B. & C.

Still another specimen of green-spored *Hypocrea* was described by Mr. Ellis as being at first yellowish. Both of these specimens when examined in 1906 showed the stromata to be entirely black with a greenish bloom, which came about from the dusting out of the spores from the perithecia.

The notes on the specimens in the Ellis collection, as well as the observations of the writer on both herbarium and fresh material which has been collected often and in various localities, tend to confirm the opinion that *Hypocrea chlorospora* B. & C. is identical with *Hypocrea gelatinosa* (Tode) Fries and that the range of coloration in this species is from bright golden or lemon-yellow in very young specimens to dirty greenish as the spores mature and finally black with a greenish bloom, which comes from the dusting out of the spores from the perithecia as the specimens become more aged.

This view is strengthened by the fact that Tode in his original description recognized two varieties, *viridis* (green) and *lutea* (yellow), and Fries later recognized a third, *umbrina* (dark).

Hypocrea apiculata Cooke & Peck (Ann. Rep. N. Y. State Mus. **29**: 57) also shows some rather marked color changes. This species has been studied from numerous collections of fresh material, the identification of which has been confirmed by Mr. Peck, one of the authors of the species. In specimens collected in good condition the stromata are of a bright orange-yellow color. If specimens are dried and exposed to the light for some time the color becomes lighter until it assumes a dirty yellowish and finally becomes almost white or a dirty yellowish-white. In this case the bleached specimen might easily be mistaken for a distinct species considering the importance which has usually been attached to the color character in this genus.

One of the most striking cases of color variation has been observed in *Hypomyces lactifluorum* (Schw.) Tul. (Syn. Fung. Car. 4). This species has been studied from various exsiccati in the herbarium of the New York Botanical Garden, including both American and foreign specimens and during the past season ample opportunity has been afforded to carry on field observations with the same species.

Hypomyces purpureus Peck (Bull. Torrey Club **25**: 327) is stated in the original description to differ from *Hypomyces lactifluorum* (Schw.) Tul. only in the color of the stroma, which is purple instead of orange-yellow. Studies in the herbarium convinced the writer that the two species were identical, but for lack of suitable material the matter could not be demonstrated absolutely. From recent studies in the field the fact has been established beyond the shadow of a doubt.

During the last season in a piece of aspen timber on the Red River near Fargo, North Dakota, numerous specimens of *Lactaria* were found, all of which were entirely parasitized by *Hypomyces lactifluorum* (Schw.) Tul. The normal color of the plants of this species is a bright orange-yellow and the striking character of the color might be illustrated by the following incident: The collector on returning from a collecting trip with a basket partially filled with the plants of this species chanced to pass a vehicle in which a little boy was heard to remark to his mother "O mama, see the big basket of orange peel!" While most of the specimens collected showed the normal orange color, in looking over the field a number were noted which showed the purple color characteristic of *Hypomyces purpureus* Peck. But in every such case the host showed evidences of decay and in advanced cases the host had become soft and fallen in a heap. In these extreme cases of decay the purple color was very prominent and would readily suggest to the mind of the collector the association of the purple color with decay.

In order to test the matter a simple experiment was conducted. A plant which showed the normal orange-yellow color was selected and cut into two pieces. The one was placed in a moist chamber and the other dried at once. As the moist specimen decayed, it assumed the characteristic purple color of *Hypomyces purpureus*

Peck and the other half which was dried immediately retained the orange-color of *Hypomyces lactifluorum* (Schw.) Tul. thus proving the identity of the two species. Dried specimens of each were mounted in the herbarium of the writer and kept for future reference.

Colors are not equally changeable in all cases, neither are the conditions which bring about these changes the same for different species. In *Hypocrea citrina* (Pers.) Fries, which is normally of a bright lemon-yellow color, the dried specimens have been exposed to the light for several months and no change in color detected, while specimens of *Hypomyces apiculata* Cooke & Peck are entirely bleached when treated in the same manner. However, *Hypocrea citrina* (Pers.) Fries, if exposed to conditions of excessive moisture, loses its bright color and takes on a dull yellow, approaching a brown.

The conclusions of the present paper are that the evidence, which is adequate in most cases, suggests the reduction of the following species which are based primarily on color to the list of synonyms: *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., *Nectria nigrescens* Cooke, and *Nectria Meliae* Earle, being based on aged and more or less discolored specimens of *Nectria purpurea* (L.) W. & S.; *Hypocrea chlorospora* B. & C. on an aged specimen of *Hypocrea gelatinosa* (Tode) Fries; and *Hypomyces purpureus* Peck a condition of *Hypomyces lactifluorum* (Schw.) Tul. in process of decay. Further, that the description of new species in the present order based on color *alone*, until the color variation of the various species or the order can be determined, leads to nothing but confusion. Only a few of the more striking cases of color variation have been mentioned here and those with the hope of impressing upon co-workers the necessity of more careful field study rather than a haphazard description of new species based on characters which may prove constant but which in many cases are most changeable.

A monograph of the North American Hypocreales is in course of preparation by the writer and material is desired from any part of North America.

In preparing this paper I am indebted to the New York Botanical Garden for unrestricted use of library and herbarium,

including the Ellis collections, and to the Royal Botanic Gardens of England for the several cotype specimens referred to in the paper; also to Mr. C. H. Peck for the determination of one species used and to the late L. M. Underwood for suggestions on various points.

NORTH DAKOTA AGRICULTURAL COLLEGE,
AGRICULTURAL COLLEGE, NORTH DAKOTA.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 115

SOME NORTH DAKOTA HYPOCREALES

By FRED J. SEAVER

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Some North Dakota Hypocreales

Fred J. Seaver

For some time past the writer has been engaged in the preparation of a monograph of the North American Hypocreales and the year spent in North Dakota, in the employ of the North Dakota Agricultural College, afforded a fair opportunity for the study of the various species of this order in that particular locality. While the work on the local fungi of that state was not limited to the order treated here, an especial effort was made to accumulate as much material of this order as possible. All of the species reported here were collected in the summer and autumn of 1907 and the spring of 1908. Most of the material was collected near Fargo, in the extreme eastern part of the state, but several specimens were obtained at Hawk's Nest, a low range of hills near the central part of the state, the ravines of which are shaded by a considerable growth of forest trees.

North Dakota, being essentially a prairie state and having its timbered regions limited to narrow belts along the rivers, lakes, and ravines in mountainous districts, does not afford the most favorable conditions for the growth of those forms of fungi which thrive best in moist shaded places. But notwithstanding the unfavorable conditions, the season spent in work on the fungus flora of this state was rewarded with a surprisingly large number of the saprophytic forms, while parasitic fungi which occur in more open regions were found to be most abundant.

The order Hypocreales is represented by approximately two hundred species in the whole of North America, and it would not be expected that a large number of species of a single order of this size would be collected in a given locality during one season. The list is published at this time, not on account of the large number collected, but to add to the knowledge of the distribution of this order in North America, and since there is little published work on the fungi of North Dakota, it is hoped the list will be of interest to some.

Of the twenty species reported here one at least deserves especial mention. *Nectria tuberculariformis* (Rehm) Winter was collected in the autumn of 1907 on herbaceous stems and one specimen was found in full fruit on the bark of a dead branch. No specimen of this species had previously been seen in the collection of North American Hypocreales examined and up to the present time no record of it from North America has been seen. During the spring of 1908 a quantity of the material was collected on dead stems of nettle, on which host the species has been reported in Europe. The species, while a true stromatic *Nectria*, is specifically very distinct from any of the other forms of the genus that have been examined. The stroma is tubercular, very distinct in outline, and rounded or more often elongated. The perithecia are small and instead of being cespitose on the stroma so as to cover it almost completely, as is usually the case, they are entirely superficial and distributed over its surface, being often scattered but occasionally crowded. The species is of interest not only on account of its distribution but for its peculiar specific characters.

The identification of the species recorded here has been facilitated by access to the collections of the New York Botanical Garden, with its numerous types, as well as by the types that have been received from individuals during the course of the work on the order.

Synopsis of the genera

Perithecia free on the substratum, or entirely superficial on a sessile stroma.
- Perithecia dark blue with transmitted light (nearly black to the naked eye), spores with 3 or more septa. — I. GIBBERELLA.
- Perithecia normally bright colored, of some shade of red, yellow, or brown (often becoming dark with age).
  - Spores 2-celled. — II. NECTRIA.
  - Spores muriform. — III. PLEONECTRIA

Perithecia more or less immersed in a common matrix, varying from a cottony subiculum to a distinct fleshy stroma.
- Matrix consisting of a cottony subiculum in which the perithecia are seated, usually growing on other fungi; spores fusiform. — IV. HYPOMYCES.
- Matrix consisting of a distinct fleshy stroma, sessile or erect; spores filiform or subglobose.
  - Asci 16-spored (by the breaking of each spore into two); spores subglobose; stroma sessile (very rarely erect). — V. HYPOCREA.
  - Asci 8-spored; spores filiform, nearly as long as the ascus; stroma erect (very rarely subsessile).

Stroma springing from a sclerotium formed in the ovaries of plants.	VI. CLAVICEPS.
Stroma springing from the bodies of dead insects, larvae, or underground fungi.	VII. CORDYCEPS.

I. GIBBERELLA

GIBBERELLA PULICARIS (Fries) Sacc. Very common on old corn-stalks about Fargo. This fungus is reported to have as its conidial phase species of *Fusarium*. The mature fruit appears on dead materials and its connection with a *Fusarium* suggests a possibility of its association with plant diseases. The life-history of this plant should be more carefully studied.

II. NECTRIA

a. Perithecia solitary and free on substratum.

NECTRIA PEZIZA (Tode) Fries. This is one of the most common of the non-stromatic forms of *Nectria* and occurs on various kinds of dead materials. It is perhaps most common on decayed wood but is often found on old fungi and one very good specimen was collected in North Dakota on a piece of old burlap sacking. The species is characterized by the rather large nearly globose perithecia which collapse when dried so as to resemble a small *Peziza*, for which the species has often been mistaken. The spores also are characteristic, being broadly elliptical and non-constricted. Various collections were made at Fargo and Hawk's Nest.

NECTRIA EPISPHAERIA (Tode) Fries. On various kinds of sphaeriaceous fungi. The species is distinguished from *Nectria sanguinea* Bolton by its occurrence in this kind of a habitat. The forms occurring on fungi show a strong tendency to collapse from the two opposite sides, which tendency, although less common, is not entirely lacking in young specimens of *Nectria sanguinea* Bolton. It is thought doubtful if the two are specifically distinct. Both are characterized by the blood-red color of the perithecia.

b. Perithecia borne on a stroma, often cespitose.

NECTRIA COCCINEA (Pers.) Fries. Several specimens on dead branches in woods near Fargo. The species is distinguished by the scarlet-red perithecia, borne in clusters on a yellowish stroma.

NECTRIA PURPUREA (L.) Wilson & Seaver.

Nectria cinnabarina (Tode) Fries.

On dead branches of various kinds of trees and shrubs. The mature fruit of this plant occurs on dead branches and usually in great abundance, but its conidial phase is reported to be parasitic. The species is recognized by the rough perithecia, which vary in color from rather bright cinnabar-red to dull brownish black and are borne in dense clusters on a tubercular stroma.

NECTRIA VERRUCOSA (Schwein.) Sacc. On dead branches in woods near Fargo. The perithecia and spores of this species are identical with those of the preceding. The species is distinguished by the fact that the stroma is depressed, never rising above the surface of the bark, while in the preceding it is tubercular and very prominent.

NECTRIA TUBERCULARIFORMIS (Rehm) Winter; Rabenh. Krypt. Flora 1^2: 118, 119. 1887.

Hypocrea tuberculariformis Rehm, Ber. Naturh. Ver. Augsburg **26**: 106. 1881.

Exsicc.: Rehm, Ascom. *435*, *679*.

Other specimens examined: N. Dakota, *Seaver*, various collections.

Habitat: Herbaceous stems (especially *Urtica* sp.), bark, and dung.

Stroma tubercular, rounded or more usually elongated, nearly smooth or in dried specimens often longitudinally striated, pinkish or rose-colored, becoming dull red with age.

Perithecia superficial, solitary or more or less crowded, small, averaging about 200 μ in diameter, smooth or nearly so, globose with a rather prominent ostiolum, delicately rose-colored, becoming slightly collapsed from above when dry; asci clavate, 8-spored, about 40–50 $\mu \times$ 6–7 μ; spores 1- or 2-seriate, mostly 2-seriate above and 1-seriate below, usually a little broader above, fusoid, and a little constricted at the septum, with two or more small oil-drops in each cell, 8–11 $\mu \times$ 3–4 μ.

The conidial phase is often very abundant but the mature fruit is less common.

III. PLEONECTRIA

PLEONECTRIA BEROLINENSIS Sacc. On dead branches of red currant in the Agricultural College Gardens and also on branches

of wild black currant in woods near Fargo. Very destructive to currants in cultivation. In external appearance the plants of this species very closely resemble those of *Nectria purpurea* (L.) W. & S. but the species is very distinct in the spore characters. The spores instead of being 2-celled are divided both longitudinally and transversely into numerous cells.

IV. HYPOMYCES

HYPOMYCES AURANTIUS (Pers.) Fuckel. On decaying fungi of various kinds. Various collections, Fargo and Hawk's Nest. The fungus presents to the naked eye a rusty red appearance due to the cottony stroma, which spreads over the substratum often for several inches. Closer examination will show the orange-colored perithecia scattered over the stroma. The species is rather common.

HYPOMYCES LACTIFLUORUM (Schwein.) Tul.

Hypomyces purpureus Peck.

On some agaric in woods near Fargo. The stroma of this plant, which entirely covers the hymenium of the host infected, presents an orange-yellow color. Scattered over the orange surface are the perithecia, which are nearly immersed, with necks protruding. As the plants of the host decay, they become purple, which accounts for the specific name of the synonym given above. The species was found to be abundant in one locality.

HYPOMYCES OCHRACEUS (Pers.) Tul. On some agaric in same locality as preceding. The plants differ from the preceding by the fact that the stroma is almost entirely white when fresh, becoming yellowish as it dries. There is also a marked difference in the spores.

HYPOMYCES POLYPORINUS Peck. On old plants of *Coriolus versicolor*, in woods near Fargo. The plants of this species occur on the under surface of the host and would scarcely be seen except by accident or special search. Characterized by the amber color of the perithecia and the habitat as well as by spore characters. Found in considerable abundance. I am indebted to Professor C. H. Peck for an authentic specimen of this species for comparison.

HYPOMYCES ROSELLUS (Albert. & Schwein.) Tul. Several collections on the under side of rotten logs in woods near Fargo.

The species is well marked by the delicate rose color of the subiculum and perithecia as well as by spore characters.

V. HYPOCREA

HYPOCREA CITRINA (Pers.) Fries. On dead limbs of basswood, especially where the outer bark has been removed. Plants form a bright lemon-yellow stroma, often several inches in extent on the substratum. The perithecia are seen as little dots over the surface of the stroma. The plants resemble those of the preceding genus but are readily distinguished by the spore characters. Considerable quantity of this material has been collected but always on the same host.

HYPOCREA PATELLA Peck. The stroma in this species is very small as compared with the preceding and not so bright-colored. In the specimens of this species collected, it seems to show a tendency to grow on old sphaeriaceous fungi. This has been compared with specimens identified by Professor Peck.

HYPOCREA RICHARDSONI Berk. & Mont. Very common on limbs of *Populus tremuloides* in woods near Fargo. No perithecia have been seen in any of the specimens which have been examined. Although in external appearance the plants resemble a *Hypocrea*, it is doubtful if they rightfully belong to this genus.

HYPOCREA RUFA (Pers.) Fries. The specimens which were collected in Fargo were small and not fair examples of this species, but they seem to belong here.

VI. CORDYCEPS

CORDYCEPS MILITARIS (L.) Link.

Isaria farinosa Fries.

On larvae of insects in Fargo woods. Only the conidial phase of this plant was collected in North Dakota but that occurred in considerable abundance and doubtless the mature fruit would have appeared at the proper season. The conidial phase is characterized by the snow-white feather-like growth, with its yellowish stem which springs from larvae that are buried under leaves and soil.

CORDYCEPS PISTILLARIAEFORMIS Berk. & Broome. On scale-insects on branches of *Xanthoxylum americanum* in woods about Fargo. The plants of this species collected do not show mature

asci and spores but otherwise correspond well with other specimens of this species that have been examined.

VII. CLAVICEPS

CLAVICEPS PURPUREA (Fries) Tul. The species was collected by the writer on several hosts including *Bromus*, *Agropyron*, and cultivated rye, in the Agricultural College grounds. The fungus is a parasite and besides causing some reduction in the crop is also the cause of a characteristic disease among cattle. It is used as an official drug under the name of ergot.

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BRONX PARK, NEW YORK CITY

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 119

NORTH DAKOTA SLIME-MOULDS

By FRED J. SEAVER

NEW YORK

1908

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North Dakota slime-moulds

Fred J. Seaver

During the fall of 1907 and spring of 1908, in connection with the study of the fungus flora of North Dakota, a number of species of slime-moulds were collected, and since there is no available literature on this particular phase of the cryptogamic flora of the state, it is thought advisable to publish the list at this time. The work above mentioned was carried on in connection with the North Dakota Agricultural College and specimens of the species reported on here are preserved in the herbarium of that institution, to which I am indebted for the privilege of carrying on the work.

With few exceptions, such as that of the disease known as the club-rot of cabbage, the slime-moulds are not known to be of any economic importance, and since they are usually small and grow in out of the way places little attention is given to them. But notwithstanding their failure to appeal to those interested in the commercial phases of the botanical science only, their strange life-history, delicate structure, and uncertain relationship with other groups of plants and animals never fail to arouse the interest of the student in the class-room and it was for this reason that most of the species reported here were first collected.

In preparing this list acknowledgments are due to Professor T. H. Macbride, of Iowa, for identification or confirmation of the identification of the species named below.

PHYSARACEAE

Cienkowskia reticulata (Albert. & Schwein.) Rost.

This is the only species of the genus and according to Professor Macbride, in the North American Slime-moulds, is very rare. The species was at first mistaken for an immature plasmodium, which it very closely resembles.

Diderma crustaceum Peck.

Common and rather attractive. The species has been collected several times in North Dakota, usually on the stems of herbaceous

plants and often some distance above ground, an adaptation for spore distribution.

DIDYMIUM SQUAMULOSUM (Albert. & Schwein.) Fries.

On leaves and decaying materials of various kinds. A common species.

FULIGO OVATA (Schaeff.) Macbr.

This is a common species and one which often attains considerable size. One specimen collected on a rotten log in North Dakota was from six to eight inches in diameter and smaller specimens were found to be very common.

PHYSARUM CONTEXTUM Pers.

Several collections were made on decaying materials of various kinds in woods near Fargo.

TILMADOCHE VIRIDIS (Bull.) Sacc.

Plants collected on rotten wood. The species is not uncommon and has a wide distribution.

STEMONITACEAE

STEMONITIS MAXIMA Schwein.

Numerous specimens were collected on bark and wood of *Tilia americana*, for which substratum it shows a decided preference. Widely distributed.

STEMONITIS SMITHII Macbr.

The specimens, collected in similar localities to the preceding, were mostly larger and easily distinguished from that species by the color of the spore mass, which is ferruginous instead of purplish black. Rather common.

CRIBRARIACEAE

DICTYDIAETHALIUM PLUMBEUM (Schum.) Rost.

Several collections on decaying wood. The plants are depressed and spread out, becoming 1–2 cm. in diameter and recognized by these characters and the ochraceous color. The one species known to North America has a wide distribution.

DICTYDIUM CANCELLATUM (Batsch) Macbr.

One of the most variable species of the group, the plants being either long- or short-stemmed and very variable in color.

TUBIFERA FERRUGINOSA (Batsch) Macbr.

Collected on rotten wood and distinct in the tubiferous sporangia, which persist long after the shedding of the spores. The sporangia occur in dense masses.

LYCOGALACEAE

LYCOGALA EPIDENDRUM (Bux.) Fries.

The young phases of this plant are often met with in woods, and the bright red color of the plasmodium of the forming sporangia make them rather conspicuous objects. At maturity, however, the sporangia lose their bright color and become more nearly the color of the substratum on which they occur. Said to be the most common slime-mould in the world.

TRICHIACEAE

ARCYRIA INCARNATA Pers.

The plants of this species are often found closely crowded on rotten stumps, sometimes covering an area of several inches. At maturity the delicate threads of the capillitium push out so that the entire group of plants resembles rich flesh-colored velvet.

ARCYRIA DENUDATA (L.) Sheld.

Plants resembling those of the preceding species but distinguished by the dull reddish brown color. The species was found to be common but did not occur in such abundance as the preceding.

HEMITRICHIA CLAVATA (Pers.) Rost.

Common on rotten wood and distinguished by the stipitate, cup-shaped remains of the sporangia containing the golden yellow capillitium. The twisted rope-like appearance, which is one of the characteristics of the genus, is revealed only by microscopic examination.

HEMITRICHIA VESPARIA (Batsch) Macbr.

At once recognized in the field as distinct from the preceding by the dark reddish purple color of the sporangia. Several collections made on rotten wood. The species is common.

TRICHIA PERSIMILIS Karst.

Rather common and widely distributed in North America.

OLIGONEMA FLAVIDUM (Peck) Massee.

The sporangia of this species grow closely crowded together in little masses and the species is quite distinct in this character and the bright yellow color of the sporangia.

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NOTES ON NORTH AMERICAN HYPOCREALES—I. NEW AND NOTEWORTHY SPECIES

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. I, No. 1, January, 1909.

NOTES ON NORTH AMERICAN HYPOCREALES—I. NEW AND NOTEWORTHY SPECIES

FRED J. SEAVER

The genus *Hyponectria,* founded by Saccardo in 1878, differs from *Nectriella* in the subepidermal character of the perithecia. Six species have been referred by Saccardo to this genus, in various volumes of his Sylloge Fungorum, one of which, *Hyponectria Gossypii* (Schw.) Sacc., the only North American representative of the genus, has since been shown not to be a fungus at all.* This leaves the genus, at present, entirely unrepresented in North America so far as the records show.

In working over the material in the Ellis collection at the New York Botanical Garden, one species, *Nectriella Cacti* Ellis & Everh., has been found to show the true hypodermal character of the perithecia and should be referred to this genus. The ostiola form disc-like expansions above the surface of the epidermis but the perithecia themselves, while prominent, are covered by the thin epidermis of the host, a fact which was not mentioned by Mr. Ellis in his original description and one which apparently escaped his notice.

One species of this genus has also been collected by the writer in North Dakota on dead stems of herbaceous plants. As in the preceding, the perithecia of this species are prominent, though covered, forming minute, orange pustules scattered over the surface of the host. The ostiola also form the disc-like, slightly hairy expansions above the surface of the epidermis. This form is distinct in its spore characters from the preceding as well as from any of the species which have been previously described as representative of this small genus and is here offered as new, being now one of the two representatives of the genus for North America.

* U. S. Dept. Agric. Div. Veg. Phys. Path. Bull. 17: 51. 1899.

In addition to the above, one species of *Nectria* was collected and studied by the writer during the autumn of 1906 which it is thought best to describe at this time. The plants occur on partially decayed seeds of skunk-cabbage (*Spathyema foetida*) and were collected commonly during the autumn of the above date in a swampy place in the vicinity of New York City. The conidial phase which forms a whitish or pinkish mass over the surface of the decaying seeds, has much the gross appearance of some of the common species of *Fusarium* but differs in its microscopic details. The perithecia later appear in small clusters seated on the stromata formed by the conidial phase of the plant. During the past season, 1908, the locality in which this species was originally collected was visited once, but at that time none of the plants were found.

HYPONECTRIA Sacc. Michelia 1: 250. 1878

Perithecia globose or subglobose, subepidermal, often becoming erumpent; asci 8-spored; spores elliptical or subelliptical, hyaline, simple. Distinguished from *Charonectria* by the simple spores.

Type species: *Hyponectria Buxi* (DC.) Sacc.

Spores 5–6 × 1.5–2 mic., on stems of *Opuntia* sp. 1. *H. Cacti.*
Spores 10 × 2–2.5 mic., on herbaceous stems. 2. *H. dakotensis.*

1. **Hyponectria Cacti** (Ellis & Everh.)

Nectriella Cacti Ellis & Everh. Jour. Myc. 8: 66. 1902.

Perithecia minute, scattered, subepidermal, globose or subglobose, expanded above the epidermis into a disc-like ostiolum, perithecia red, with ostiolum lighter, whitish (in preserved specimens), about 200 mic. in diameter; asci cylindrical to clavate, 8-spored, 40–50 × 3–4 mic.; spores 2-seriate, simple, hyaline, straight or curved, 5–6 × 1.5–2 mic.

On stems of *Opuntia* sp.

TYPE LOCALITY: Alabama.

DISTRIBUTION: Known only from type locality.

SPECIMENS EXAMINED: Alabama, *Carver 584* (type).

2. **Hyponectria dakotensis** sp. nov.

Perithecia scattered or occasionally 2 or more in close contact, subepidermal, becoming more or less erumpent, long, covered

by the thin, whitish epidermis of the host, scattered over whitish patches on the substratum; ostiolum forming a disc-like expansion above the surface of the epidermis, with a distinct perforation in the center, slightly hairy, especially near the margin of the disc, where the hairs appear as a delicate fringe; perithecia 200 mic. in diameter; asci clavate, 8-spored, 30–45 × 5 mic.; spores mostly 2-seriate above, often 1-seriate below, fusoid, with usually 2 large oil-drops, and 1–2 smaller ones toward either end, 10 × 2–2.5 mic., paraphyses present, delicate.

On herbaceous stems (*Ambrosia trifida?*).

TYPE LOCALITY: Fargo, N. Dakota.

DISTRIBUTION: Known only from type locality.

The perithecia of the present species are so minute that they are easily overlooked and were first noted in connection with the study of other species of fungi. They are scattered over whitish patches on the surface of the substratum and although the substratum is whitened where the perithecia occur there is apparently no superficial mycelial growth. Two collections of the species were made by the writer in the same locality near Fargo.

The genus *Charonectria* Sacc. differs from the present genus in possessing septate instead of simple spores. The presence or absence of the septum in case of very small spores is sometimes difficult to determine and in the North Dakota specimen the spores which have two large oil-drops often appear to be septate but no definite septum could be made out. The genus *Charonectria* is also represented in North America by a single species which is quite different from the species here described, not only in the presence of septate spores but in the size of both plants and spores as well.

Nectria semenicola sp. nov.

Conidial phase consisting of a white mycelial growth which covers the substratum, finally heaping up at various points forming pinkish stomata; conidiophores erect, much branched, branches ascending perpendicularly, bearing at their summits, elliptical, hyaline conidia; conidia 5–7 × 2–3 mic., with 1–2 oil-drops.

Perithecia cespitose in small, dense clusters, with numerous scattered individuals; clusters confluent, often covering the most

of the exposed surface of the seed; individual perithecia nearly globose, with a minute, papilliform ostiolum, smooth or nearly so, 250 mic. in diameter, at first orange, fading in drying to golden-yellow or whitish; asci clavate, 40–50 mic. long, 8-spored; spores mostly 2-seriate or irregularly crowded, hyaline, 1-septate, a little constricted at the septum, 10–14 × 3–3.5 mic.

On partially decayed seeds of skunk-cabbage (*Spathyema foetida*).

TYPE LOCALITY: New York City.

DISTRIBUTION: Known only from type locality.

The perithecia and spores of this species do not differ materially from some of the species of the genus which occur on bark of various trees. However, the habitat, which is in itself interesting, and the peculiar appearance of the conidial phase seem to distinguish this form from any of the species examined.

A specimen collected in the propagating house of the New York Botanical Garden on beans which had been used for experimental purposes and allowed to partially decay corresponds so far as we can see with those occurring on the seeds of skunk-cabbage.

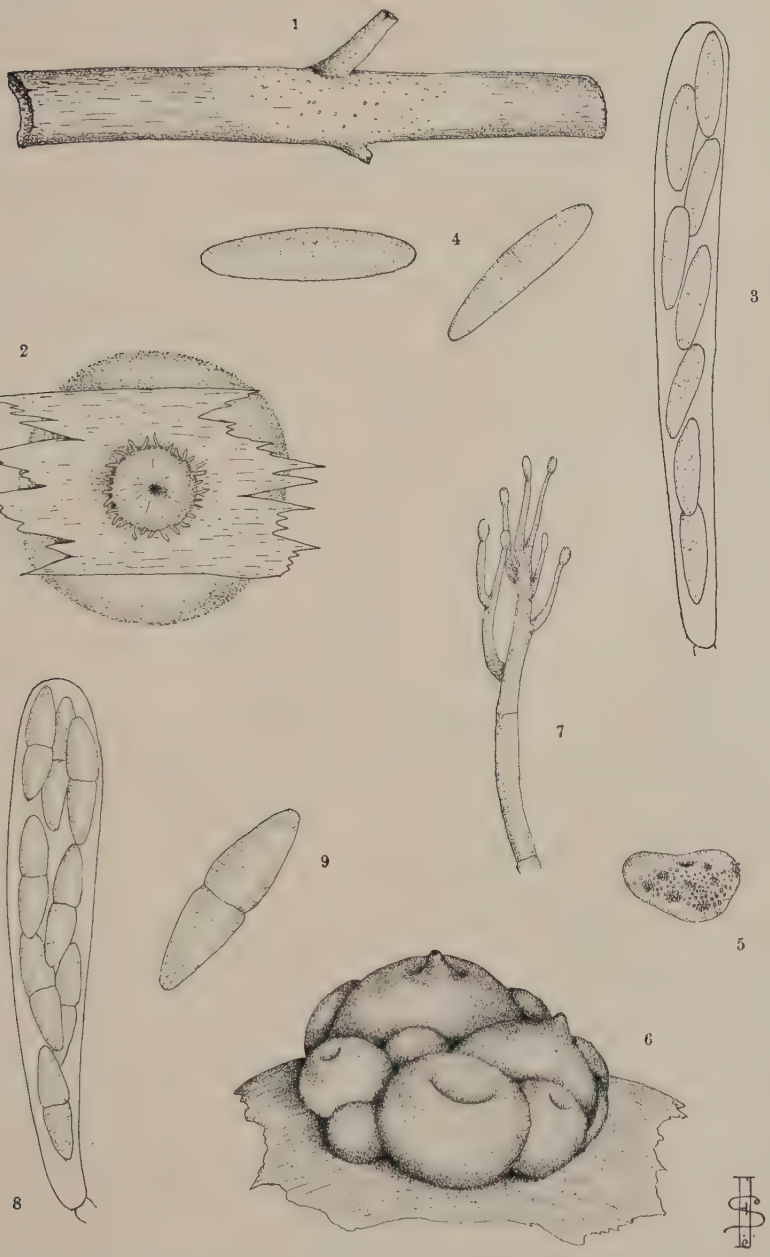
EXPLANATION OF PLATE II.

FIGS. 1–4. *Hyponectria dakotensis* sp. nov.

1. Habitat, showing plants natural size.
2. Ostiolum as it appears enlarged (surrounding epidermis diagrammatic).
3. Ascus with spores, × 2,000.
4. Two spores showing oil-drops within, × 2,500.

FIGS. 5–9. *Nectria semenicola* sp. nov.

5. Habitat, showing plants natural size.
6. Cluster of perithecia showing gross characters.
7. Conidiophore with conidia, × 400.
8. Ascus with spores, × 2,000.
9. A single spore, × 2,500.



1–4. HYPONECTRIA DAKOTENSIS Seaver

5–9. NECTRIA SEMENICOLA Seaver

DISCOMYCETES OF NORTH DAKOTA

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. I, No. 3, May, 1909.

DISCOMYCETES OF NORTH DAKOTA

FRED. J. SEAVER

The following is a list of the discomycetes (cup-fungi) collected and studied in North Dakota during the seasons of 1907–8. When not otherwise indicated the collections were made by the writer.

Hymenium exposed from the first, plants not usually cup-shaped, disc-shaped, boat-shaped or linear. 1. HELVELLINEAE.

Hymenium at first closed, plants cup-shaped, disc-shaped, boat-shaped or linear, opening by a circular, star-like or slit-like aperture.

Hymenium exposed at an early stage, plants cup-shaped or disc-shaped. 2. PEZIZINEAE.

Hymenium long, enclosed in a firm covering, opening with a star-like or slit-like aperture.

Opening for the most part with a star-like aperture. 3. PHACIDIINEAE.

Opening with a slit-like aperture. Plants boat-shaped or linear. 4. HYSTERIINEAE.

1. HELVELLINEAE

Plant large, consisting of a stem and globose pitted head. 1. MORCHELLA.

2. PEZIZINEAE

Plants small, 1–2 mm. in diameter, forming orange or salmon-colored masses 1–3 cm. in diameter on burnt soil. 2. PYRONEMA.

Plants not forming confluent masses and not usually occurring exclusively on burnt soil (except a few species not here recorded).

Externally clothed with dark-colored bristly hairs. 3. LACHNEA.

Externally naked or hairs when present light-colored, usually white.

Plants large, 1–8 cm. in diameter, cup-shaped, urn-shaped or saucer-shaped.

Plants stipitate, often attached to sticks in woods.

Within scarlet, without whitish, slightly hairy. 4. SARCOSCYPHA.

Within and without dark brownish-black. 5. URNULA.*

Plants sessile, on wood, soil, etc.

* Often included with the Phacidiineae.

Juice turning yellow when flesh is broken. 6. GALACTINIA.
Juice remaining colorless. 7. PEZIZA.
Plants medium or small, 1 cm. or less in diameter.
Occurring on dung of animals (except one species which occurs on old paper, cloth, etc., and a few others not here recorded).
Spores entirely colorless.
Asci 8-spored, plants yellowish, cinereous or flesh-colored.
Plants with conspicuous, colorless spines. 8. LASIOBOLUS.
Plants without spines. 9. ASCOPHANUS.
Asci 32-spored, plants white. 10. THECOTHEUS.
Spores colored, at first bright purple, later brown.
Spores free in the ascus. 11. ASCOBOLUS.
Spores united in a ball in the ascus. 12. SACCOBOLUS.
Occurring on wood, herbaceous stems, living leaves, etc.
Plants superficial on the substratum.
Clothed with a dense covering of soft, light-colored hairs.
Plants sessile. 13. TRICHOPEZIZA.
Plants stipitate, stem often slender. 14. DASYSCYPHA.
Not clothed with hairs.
Plants stipitate, stem stout, or slender.
Stem short, stout, plants occurring on wood.
Hymenium bright yellow, disc nearly plane. 15. HELOTIUM.
Hymenium smoky-brown, beaker-shaped. 16. GEOPYXIS.
Stem comparatively long and slender, on herbaceous stems, etc.
Plants small, 1 mm. or less in diameter. 17. PHIALEA.
Plants medium, 3–5 mm. in diameter. 18. CIBORIA.
Plants sessile.
Substance soft and plants not black in color.
Medium, 3–5 mm. in diameter.
Dark purple, rubbery, spores colorless. 19. CORYNE.

Greenish, spores colored, greenish-brown. 20. PHAEOPEZIA.
Small, not exceeding 2 mm. in diameter.
Plants disc-like, on leaves, wood, etc. 21. MOLLISIA.
Plants forming spots on leaves, alfalfa, etc. 22. PSEUDOPEZIZA.
Substance hard, forming black discs on wood, etc.
Spores with transverse septa only.
Spores 1-septate, brownish. 23. KARSCHIA.
Spores more than 1-septate, colorless.
Spores filiform, breaking into joints. 24. BACTROSPORA.
Spores not filiform. 25. PATELLARIA.
Spores muriform. 26. BLITRYDIUM.
Plants formed below the epidermis and bursting through usually in clusters.
Plants medium, 3 or more mm., usually cup-shaped. 27. CENANGIUM.
Plants small, 1–2 mm. mostly disc-shaped. 28. DERMATEA.

3. PHACIDIINEAE

Plants forming light-colored linear patches on old wood, etc. 29. PROPOLIS.

4. HYSTERIINEAE

Plants almost entirely superficial.
Lips spreading so that the plants become subpatellate. 30. HYSTEROPATELLA.
Lips tightly closed or only slightly spreading.
Spores muriform, with transverse and longitudinal septa.
Spores colored brown. 31. HYSTEROGRAPHIUM.
Spores colorless. 32. GLONIOPSIS.
Spores 1-septate, colorless. 33. GLONIUM.
Plants submerged, surface even with surface of substratum. 34. HYPODERMA.

1. HELVELLINEAE

1. MORCHELLA

MORCHELLA ESCULENTA (L.) Pers. A species well known by its stipitate, subglobose, deeply-pitted head. Commonly classed with the mushrooms and much valued for its edible qualities.

Observed by the writer from material collected by one of the students of the Agricultural College.

2. PEZIZINEAE

2. Pyronema

PYRONEMA OMPHALODES (Bull.) Fuckel. Forming salmon-colored patches often several cm. in diameter on soil where wood or rubbish has been burned. While the individual plants are small they run together so closely that they present the appearance of one continuous mass which is surrounded by a spider-web-like halo of mycelium. The species was collected often in North Dakota about Sykeston on damp soil where there was no apparent trace of fire, but the places had doubtless been burned over, as the plants are usually restricted to burnt places. Also collected elsewhere on soil which had been sterilized by heating.

3. Lachnea

LACHNEA SCUTELLATA (L.) Sacc. Saucer-shaped plants as large as 1 cm. in diameter with a bright red hymenium surrounded by a border of dark-colored hairs. On wood and the surrounding soil. Collected at Sykeston.

LACHNEA SETOSA (Nees) Sacc. Occurring often closely crowded on decaying mossy logs in woods. Similar to the preceding but plants one-third as large and hairs much longer. Collected on old box-elder logs in woods near Fargo.

LACHNEA HEMISPHERICA (Wigg.) Gill. Hemispherical plants about the size of a large acorn-cup, growing on moist soil in shaded places in woods. Inside of cup whitish or bluish-white, externally clothed with chestnut-brown, bristly hairs. Collected in woods near Fargo.

4. Sarcoscypha

SARCOSCYPHA COCCINEA (Jacq.) Cooke. Plants found in woods in spring attached to partially buried sticks. Inside of cups, which are often 3 cm. or more in diameter, brilliant scarlet, outside whitish and more or less downy with soft white hairs.

One of the most attractive of the discomycetes on account of its brilliant color. Observed from material collected by one of the students of the Agricultural College.

SARCOSCYPHA OCCIDENTALIS (Schw.) Cooke. Habitat similar to that of the preceding but plants occur all summer. Stem usually longer and more slender, cups smaller and shallow, saucer-shaped instead of deep funnel-shaped as in the preceding. Collected commonly in woods about Fargo.

5. URNULA

URNULA CRATERIUM (Schw.) Fries. Occurring in woods on buried sticks, a number of specimens often attached to a single stick. Plants at first club-shaped and entirely closed, finally opening with a star-like aperture and becoming urn-shaped but margin usually notched. Outside and inside dark brownish-black. The position of this species is uncertain but on account of the manner in which the cups open the genus is often included with the Phacidiineae.

6. GALACTINIA

GALACTINIA SUCCOSA (Berk.) Cooke. Plants cup-shaped, rather large, 2–3 cm. in diameter, inside brown, externally whitish. When the flesh is broken the exuding juice turns golden-yellow. Occurring on damp soil in shaded woods. Collected near Fargo.

7. PEZIZA

PEZIZA VESICULOSA Bull. Large cup-shaped plants often 6–8 cm. in diameter, yellowish inside, whitish externally, occurring usually in dense clusters on strawy manure piles and soil fertilized with such material. The cups are at first regular in form, becoming much contorted and twisted. A common species. Collected at Sykeston.

PEZIZA REPANDA Wallr. This species occurs on decaying logs in woods, and, while it resembles the preceding in color, it differs in form, the cups soon becoming repand, leaving the hymenium convex. This is a species concerning which there is much doubt. The specimen collected near Fargo by the writer conforms with

what is usually accepted as this species. The plant was about 6 cm. in diameter.

PEZIZA BADIA Pers. The brown cup-fungus common on moist soil in woods. The specimens collected in Fargo woods were small, about 2–3 cm. in diameter, but the plants of this species often attain a size of 8–10 cm.

8. LASIOBOLUS

LASIOBOLUS EQUINUS (Muell.) Karst. The plants of this species while minute, usually occur in dense masses on dung of various kinds, especially that of horses and cows. The color varies from yellowish to reddish but the plants are always characterized by the thick covering of colorless spines. Collected on dung of horses at Sykeston.

9. ASCOPHANUS

ASCOPHANUS CINEREUS (Crouan) Boud. Plants occurring gregarious or densely crowded on dung of horses, and characterized by the grayish or often nearly black color. Collected on horse dung in a swampy place in open woods near Fargo.

ASCOPHANUS TESTACEUS (Moug.) Phill. Plants flesh-red, usually gregarious or scattered on hemp cloth, building paper, rags, etc. Specimens collected near Fargo were found on building paper near the remains of an old house.

ASCOPHANUS CARNEUS (Pers.) Boud. Similar in color to the preceding but differing in its habitat as well as in morphological characters. Rather a common species on old cow dung. Collected commonly about Sykeston.

10. THECOTHEUS

THECOTHEUS PELLETIERI (Crouan) Boud. Plants white, at first conical, later cylindrical. Common on dung of various kinds and easily characterized by its 32-spored asci, as well as by its gross characters. Collected in woods near Fargo.

11. ASCOBOLUS

ASCOBOLUS IMMERSUS Pers. Plants small and not easily seen as they closely resemble in color the substratum on which they occur, but often occurring in abundance. Characterized by the asci filled with dark purple spores which project far above the surface of the hymenium. The spores in this species are unusually large. Collected near Sykeston.

12. SACCOBOLUS

SACCOBOLUS KERVERNI (Crouan) Boud. Plants small, golden-yellow, with the hymenium dotted with the ends of the asci containing dark purple spores. A common species on dung of cows. Specimens collected at Sykeston.

SACCOBOLUS VIOLASCENS Boud. Differs from the preceding in that the plants are violet instead of golden-yellow. The species also differs in microscopic characters. Specimens collected at Sykeston on horse dung.

13. TRICHOPEZIZA

TRICHOPEZIZA SULPHUREA (Pers.) Fuckel. Plants small, occurring on herbaceous stems and characterized by a dense covering of sulphur-yellow hairs. Collected at Fargo.

TRICHOPEZIZA TILIAE (Peck) Sacc. Plants small, white, and clothed externally with a dense covering of white hairs. Common and abundant on the bark of dead branches of basswood (*Tilia Americana*). Collected commonly about Fargo.

14. DASYSCYPHA

DASYSCYPHA NIVEA (Hedw.) Sacc. Plants stipitate and clothed with a dense covering of white hairs. Specimens collected on herbaceous stems at Hawk's Nest. The species is common on decaying wood, especially oak.

15. HELOTIUM

HELOTIUM CITRINUM (Hedw.) Fries. Plants very bright lemon-yellow, and usually occurring thickly gregarious on old

wood, and sometimes becoming slightly confluent. Collected in woods near Fargo.

16. GEOPYXIS

GEOPYXIS NEBULOSA (Cooke) Sacc. Plants medium in size, beaker-shaped, smoky-brown. Occurring on decaying logs in woods. The species is distinguished by its fusiform spores. Collected commonly about Fargo.

17. PHIALEA

PHIALEA URTICAE (Pers.) Sacc. Small, pale yellow plants with a slender stem. Collected commonly about Fargo on dead stems of nettle (*Urtica* sp.).

18. CIBORIA

CIBORIA SULPHURELLA (Ellis & Everh.) Rehm. Plants medium, stipitate, stem often very long or very short according to depth at which the substratum, petioles of ash leaves, is buried under leaves and soil. This species has been observed by the writer not only in North Dakota but commonly in Iowa and New York and apparently grows wherever the ash is found. The plants are very variable in color, ranging from sulphur-yellow or yellowish-green to reddish-brown. Collected at Hawk's Nest and Fargo.

19. CORYNE

CORYNE SARCOIDES (Jacq.) Tul. Often growing in clusters from crevices in decaying logs. Of a purple color and often very dark, with the substance inclined to be tough or rubbery. A common species. Collected near Fargo.

20. PHAEOPEZIA

PHAEOPEZIA FUSCOCARPA (Ellis & Holw.) Sacc. Plants saucer-shaped or disc-shaped, occurring on the under side or near the soil on rotting logs, dark colored with a shade of green, The spores of the species are also green, becoming brown. Collected in woods near Fargo.

21. MOLLISIA

MOLLISIA CINEREA (Batsch) Karst. Plants small or medium, saucer-shaped, with a light-colored border. Common on wood and decaying herbaceous stems. Collected commonly about Fargo. The specimens occurring on herbaceous stems may be distinct from those on wood but we can see no difference.

MOLLISIA DEHNII. Rabenh. On living leaves and stems of *Potentilla* sp. The plants, when they occur, almost entirely cover the leaves and stems of the host. They are small and disc-shaped and of a rather dark color. Collected at Fargo in the Agricultural College grounds.

22. PSEUDOPEZIZA

PSEUDOPEZIZA MEDICAGINIS (Lib.) Sacc. Forming minute brown leaf-spots on the living leaves of the host and causing much damage to the crop. Collected commonly at Fargo in the Agricultural College grounds, on leaves of alfalfa.

23. KARSCHIA

KARSCHIA TAVELIANA Rehm. Forming small black discs, often in considerable numbers, on partially decayed wood. Collected about Fargo on logs of decaying ash.

KARSCHIA LIGNYOTA (Fries) Sacc. Similar to the preceding but smaller and spores also different. Collected on old wood at Hawk's Nest.

24. BACTROSPORA

BACTROSPORA DRYINA (Ach.) Mass. The genus is represented by a single species, and no previous record of it has been seen from North America. Specimens collected on dead branches of *Symphoricarpus occidentalis,* by J. F. Brenckle, at Kulm, N. D.

25. PATELLARIA

PATELLARIA ATRATA (Hedw.) Fries. Plants similar in external appearance to those of the preceding genus but very different internally. Spores much larger, colorless and many-septate. Substance with transmitted light bluish. Hawk's Nest.

PATELLARIA CLAVISPORA (Peck.) Sacc. This species is very common on bark and wood of willow and cottonwood. The spores are very different in form and color from the preceding. Collected about Fargo.

26. BLITRYDIUM.

BLITRYDIUM FENESTRATUM (Cooke & Peck) Sacc. Plants similar to those of the two preceding genera but spores much larger, broader, brown, and divided by both longitudinal and transverse septa, becoming muriform. Collected commonly on the bark of dead twigs of *Populus tremuloides,* in woods near Fargo.

27 CENANGIUM

CENANGIUM FURFURACEUM (Roth.) DeNot. Plants forming cespitose clusters bursting through the bark of the host. Collected commonly about Fargo on dead branches of *Corylus* sp. The cups remain for a long time closed, finally opening and becoming cup-shaped.

28. DERMATEA

DERMATEA sp. A species of this genus was collected in great abundance on dead branches of *Amelanchier* sp. in woods at Hawk's Nest. The species is still undetermined.

3. PHACIDIINEAE

29. PROPOLIS

PROPOLIS FAGINEA (Schrad.) Karst. Forming white lines often 1 mm. wide and several mm. long on old wood. The white surface constitutes the hymenium of the plant, which consists of asci, paraphyses and spores. Collected commonly in woods near Fargo.

4. HYSTERIINEAE

30. HYSTEROPATELLA

HYSTEROPATELLA PROSTII (Duby.) Rehm. Plants boat-shaped, and intermediate in form between *Patellaria* and *Hysterium,* the plants being at first hysteriform and later becoming subpatellate. Collected near Fargo.

31. HYSTEROGRAPHIUM

HYSTEROGRAPHIUM MORI (Schw.) Rehm. Plants linear, opening with a slit-like aperture, spores muriform, brown. Common on old wood of various kinds. Collected on old oak wood near Fargo.

HYSTEROGRAPHIUM FRAXINI (Pers.) DeNot. A very common and abundant species on bark and wood of ash. Dead branches still on the tree are often nearly covered with the small, boat-shaped plants. Very different from the preceding. The species has also been collected on *Xanthoxylum*.

32. GLONIOPSIS

GLONIOPSIS GERARDIANA Sacc. The species of this genus differ from those of the preceding in that the spores are colorless instead of brown. Collected on old oak wood, near Fargo.

33. GLONIUM

GLONIUM STELLATUM Mühl. Plants forming black stellate masses on old wood, the individual plants linear, opening with a cleft. The first appearance is a dense mass of black mycelium.

GLONIUM PARVULUM (Gerard) Sacc. Plants very small and parallel with each other, often occurring in great numbers and rather closely crowded. Collected on old stumps in woods near Fargo.

GLONIUM LINEARE (Fries) DeNot. Plants larger than the preceding and differing in spore characters. Collected on wood at Hawk's Nest.

34. HYPODERMA

HYPODERMA SCIRPINUM DC. Plants forming shining black lines on the stems of the host with a delicate slit extending lengthwise through the center. On stems of *Scirpus* sp. I am indebted to Dr. J. F. Brenckle for specimens of this species.

NEW YORK BOTANICAL GARDEN.

No 16

ASCOMYCETES AND LOWER FUNGI—FASCICLE II

GUY WEST WILSON AND FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. I, No. 3, May, 1909.

ASCOMYCETES AND LOWER FUNGI—FASCICLE II

GUY WEST WILSON AND FRED JAY SEAVER

26. ALBUGO BLITI (Biv.) Kuntze, Rev. Gen. Pl. **2**: 658. 1891

Uredo bliti Biv. Stirp. Rar. Sicilia **3**: 11. 1815.

On *Amaranthus retroflexus* L. Lapel, Ind., August 22, 1907. G. W. W.

27. ALBUGO BLITI (Biv.) Kuntze

On *Amaranthus spinosus* L. Carmel, Ind., August 29, 1907. G. W. W.

28. ALBUGO PORTULACAE (DC.) Kuntze, Rev. Gen. Pl. **2**: 658. 1891

Uredo Portulacae DC. Fl. France **5**: 88. 1815.

On *Portulaca oleracea* L. Lapel, Ind., August 22, 1907. G. W. W.

29. BASIDIOPHORA KELLERMANII (Ellis & Halsted) G. W. Wilson, Bull. Torrey Club **34**: 349. 1907

Peronospora Kellermanii Ellis & Halsted, *pro tem.;* Ellis & Everh. N. Am. Fungi *2201.* 1889. (hyponym.)

Plasmopora Kellermanii Swingle; Sacc. Syll. Fung. **9**: 342. 1891.

On leaves of *Iva xanthiifolia* (Fres.) Nutt.; Sykeston, N. Dak., summer, 1907. F. J. S.

While of a rather restricted range this species appears to be abundant in the territory which it infests, and is probably coextensive in range with its host.

30. BLITRYDIUM FENESTRATUM (Cooke & Peck) Sacc. Syll. Fung. **8**: 805. 1899

Patellaria fenestrata Cooke & Peck; Peck, Ann. Rep. N. Y. State Mus. **28**: 68. 1876.

Fargo, N. Dak., August, 1907. F. J. S.

This species is rather common in the above locality on dead twigs of *Populus tremuloides* Michx.

31. FUSICOCCUM CASTANEUM (Sacc.) Sacc. Syll. Fung. **3**: 249. 1884

Cytispora Castanea Sacc. Michelia **1**: 519. 1879.

On dead branches of *Castanea dentata* (Marsh.) Borkh., New York City, March, 1907. G. W. W.

This fungus was nowhere observed except on the immature twigs of a large branch which had been broken from a chestnut tree during a storm of the preceding summer.

32. GIBBERELLA PULICARIS (Fries) Sacc. Michelia **1**: 43. 1876

Sphaeria pulicaris Fries, Syst. Myc. **2**: 417. 1823.

On old stalks of *Zea Mays* L., Mount Pleasant, Iowa, summer, 1907. F. J. S.

33. HYPODERMA AQUILINA (Fries) Rehm, Ber. Naturh. Ver. Augsburg **26**: 68. 1881

Sphaeria aquilina Fries, Syst. Myc. **2**: 522. 1823.

On old leaf-stems of *Onoclea sensibilis* L., New York City, spring, 1907. F. J. S.

34. *Hypomyces Lactifluorum* (Schw.) Tul. Sel. Fung. Carp. **2**: 63. 1865

Sphaeria Lactifluorum Schw. Schr. Nat. Ges. Leipzig **1**: (30). 1822.

On some species of *Lactaria,* Fargo, N. Dak., summer, 1907. F. J. S.

Numerous specimens of the host were collected in woods near Fargo all of which were entirely parasitized by the fungus so that the gills were entirely eliminated.

35. HYPOMYCES POLYPORINUS Peck, Ann. Rep. State Mus. **26**: 84. 1874

On *Coriolus versicolor* (L.) Quel. = *Polyporus versicolor* (L.) Fries, Fargo, N. Dak., summer, 1907. F. J. S.

The present species was found in considerable quantity during

the past season on old sporophores of the host. The specimens have been compared with authentic material received from Professor Peck and conform well.

36. HYSTEROGRAPHIUM FRAXINI (Pers.) de Not. Disp. Pirenom. Ister. 22. 1847

Hysterium Fraxini Pers. Syn. Meth. Fung. 100. 1801.

On dead twigs of *Fraxinus,* Sykeston, N. Dak., July, 1907. F. J. S.

This fungus is very abundant on dead twigs of ash wherever the later occurs in considerable numbers.

37. MASSARIA INQUINANS (Tode) Fries, Summa Veg. Scand. 396. 1849

Sphaeria inquinans Tode, Fungi Meckl. 2: 17. *pl. 10, f. 85.* 1791.

On *Viburnum dentatum* L., The Bronx, New York City, spring, 1907. F. J. S.

The perithecia are very large and buried with the ostiola extending through the bark. The spores spread over the surface of the bark and are so large that with the hand lens they appear as coarse shining granules. The species is distinguished by the large size of its spores.

38. MITRULA PHALLOIDES (Bull.) Chev. Fl. Paris 1: 114. 1826

Clavaria phalloides Bull. Herb. France. *pl. 463. f. 3.* 1791.

On decaying leaves submerged in water in a swamp, New York City, spring, 1907. F. J. S.

39. MOLLISIA CINEREA (Batsch) Karst. Myc. Fenn. 1: 189. 1871

Peziza cinerea Batsch, Elench. Fung. Cont. 1: 197. 1786.

On herbaceous stems in swampy place, New York City, spring, 1907. F. J. S.

40. PERONOSPORA EFFUSA Rabenh. Herb. Myc. ed. I. 1880

On *Chenopodium album* L., Greencastle, Ind., August 3, 1907. G. W. W.

The bright yellow epiphyllous discolorations of this fungus were very conspicuous during the late summer in all patches of the host, not only here but in other sections of the state.

41. PHYLITAENA ARCUATA Berk. Grevillea **2**: 100. 1874

On dead stems of *Ambrosia trifida* L., The Bronx, New York City, March, 1907. G. W. W.

This species is rather common in the vicinity of New York on herbaceous stems, but is easily overlooked on account of the inconspicuous habit and the peculiar hypha-like spores which are 25–30 × 1–2 μ.

42. PHYLLACHORA GRAMINIS (Pers.) Fuckel, Symb. Myc. 216. 1869

Sphaeria graminis Pers. Syn. Meth. Fung. 30. 1801.

On leaves of *Elymus canadensis* L., Fargo., N. Dak., autumn, 1907. F. J. S.

43. PHYLLOSTICTA SMILACIS Ellis and Everh. Bull. Torrey Club **27**: 572. 1900

On *Smilax rotundifolia* L., The Bronx, New York City, September, 1906. G. W. W.

The synonymy of this species is very much involved and the fungus apparently very poorly understood.

44. PROPOLIS FAGINEA (Schrad.) Karst, Myc. Fenn. **1**: 244. 1871

Hysterium fagineum Schrad. Jour. Bot. **2**: 68. 1799.

On decaying wood, Fargo, N. Dak., August, 1907. F. J. S.

45. RHYSOTHECA HALSTEDII (Farl.) G. W. Wilson, Torrey Club **34**: 403. 1907

Peronospora Halstedii Farl.; Ellis, N. Am. Fungi *209*. 1879 (hyponym). Proc. Am. Acad. **18**: 72. 1883.

On leaves of *Bidens frondosa* L., Noblesville, Ind., August 24, 1907. G. W. W.

During the latter part of the summer it was almost impossible to find a plant of this host which was unaffected with the fungus.

46. SAPROLEGNIA FERAX (Gruith.) Nees, Nova Acta Acad. Leop. **11**[2]: 513. 1823

Conferva ferax Gruith. Nova Acta Acad. Leop. 1821.

On dead fish, New York City, spring, 1907. G. W. W.

This species is reported as common in the vicinity of New York City on fish of various species.

47. SPHAEROPSIS LINDERAE Peck, Ann. Rep. N. Y. State Mus. **39**: 45. 1896

On dead branches of *Benzoin Benzoin* (L.) Coulter, Westchester Co., N. Y., March, 1907. G. W. W.

The fungus infests the younger branches, which appear to have been killed by the mycelium of the fungus, while the sporangia develop saprophytically.

48. SPHAEROPSIS MENISPERMI Peck, Ann. Rep. N. Y. State Mus. **24**: 86. 1886

On recently dead vines of *Menispermum canadensis* L., First Mt., Orange, N. J., September 26, 1906. G. W. W.

This species, which is similar in habit to the preceding, was frequently observed in the vicinity of New York City.

49. SPHAEROPSIS SMILACIS Ellis & Everh. Jour. Myc. **5**: 149. 1899

On dead stems of *Smilax rotundifolia* L., The Bronx, New York City, March 22, 1907. G. W. W.

Not common and usually associated with other imperfect fungi.

50. TRICHOPEZIZA TILIAE (Peck) Sacc. Syll. Fung. **8**: 428. 1889

Peziza Tiliae Peck, Ann. Rep. N. Y. State Mus. **24**: 96. 1886.

Abundant on dead branches of *Tilia americana* L., Fargo, N. Dak., summer, 1907. F. J. S.

CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 122

NOTES ON NORTH AMERICAN HYPOCREALES-II. NECTRIA PEZIZA

By FRED J. SEAVER

NEW YORK
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Notes on North American Hypocreales — II. Nectria Peziza *

Fred J. Seaver

(with plate 15)

Sphaeria Peziza was described by Tode in 1791, and while there is probably no type specimen in existence, the illustrations and descriptions by Tode seem, from our observations, quite definitive of the species. While many species of the present and closely related genera cannot be distinguished except by a close microscopic study of the spore-characters, thus rendering illustrations of gross characters, only, valueless, this is not true of the one here treated. Having observed and studied this species for the past five years in the field, covering an extensive range of locality, we find that there are few members of the genus, if any, which are more easily recognized on external characters. Add to this, on microscopic examination, the broadly-elliptical, septate, non-constricted spores with a distinct oil-drop in each cell, and the species would seem to be very well marked.

This is probably one of the most common and widely distributed species of non-stromatic *Nectria*, and, as is usually the case with species which are common and subject to more or less variation, has been much studied, greatly misunderstood, and many times redescribed. The perithecia in this species are large, compared with those of other species of the genus, ranging from one third to one half millimeter in diameter and nearly globose, especially when moist, with the ostiolum only slightly prominent. The color is from pale to deep orange, becoming deeper on drying, but often fading with age to very pale yellowish or whitish. The plants are usually widely scattered but occasionally crowded, giving somewhat the appearance of a stromatic form, but no true stroma is present. The perithecia produce no well-developed hairs but are often clothed with a growth of mycelial threads, which character seems to vary with conditions. Specimens col-

* Notes on North American Hypocreales — I, appeared in Mycologia 1: 19–22. *pl. 2.* 1909.

lected in good condition are nearly smooth but become more or less roughened with age. The variation is not great but is sufficient to have led to some confusion. The perithecia at maturity, especially when dry, almost invariably collapse from the top, becoming cup-shaped and in this condition very much resemble a *Peziza*, which fact has doubtless suggested the specific name. This latter character has been the cause of considerable confusion.

Most of the American specimens examined by Mr. Ellis have been referred by him to *Nectria vulpina* (Cooke) Ellis & Everh., while most of the foreign specimens examined by the writer have been referred by various authors to *Nectria Peziza* (Tode) Fries, but notwithstanding this fact close study of American and foreign material fails to reveal any difference. *Nectria vulpina* (Cooke) Ellis & Everh. was based on material collected at Newfield, New Jersey, and was first described by Mr. Cooke as a *Peziza*, a mistake which is likely to be made on account of the close resemblance of these plants to some of the cup-fungi. The species was later transferred to the genus *Dialonectria* by Mr. Cooke and still later to the genus *Nectria* by Saccardo, and still retained as a distinct species, although there was no reliable character by which it could be distinguished from the commonly recognized species *Nectria Peziza* (Tode) Fries. A specimen in the Ellis collection which is evidently cotype material of *Nectria vulpina* (Cooke) Ellis & Everh. has been closely studied with the hope of discovering some character by which it might be distinguished from *Nectria Peziza* (Tode) Fries, but except for a very slight variation in the size of the spores this is a typical specimen of the latter species, as are the other specimens in the same collection referred to this name.

Nectria betulina, which was described from American material, seems to be a form of the present species which occurs in cracks and crevices of bark, and, the perithecia becoming crowded, presents the appearance of a stromatic form. The perithecia and spores are typical of *Nectria Peziza* (Tode) Fries and I am unable to separate it from that species. *Nectria rimincola* Cooke is a similar form. I give below a complete synonymy and description of *Nectria Peziza* (Tode) Fries, based on our own study :

NECTRIA PEZIZA (Tode) Fries, Summa Veg. Scand. 388. 1849

Sphaeria Peziza Tode, Fungi Meckl. **2**: 46. 1791.

? *Peziza hydrophora* Bull. Hist. Champ. 243. 1809.

Peziza Dasyscypha vulpina Cooke, Hedwigia **14**: 82. 1875.

Nectria rimincola Cooke, Grevillea **11**: 108. 1883.

* *Nectria lasioderma* Ellis, Am. Nat. **17**: 194. 1883.

Dialonectria vulpina Cooke, Grevillea **12**: 83. 1884.

Nectria Umbellulariae Plow. & Hark. Bull. Calif. Acad. Sci. **1**: 26. 1884.

Nectria vulpina Ellis & Everh. N. Am. Pyrenom. 103. 1887.

Nectria betulina Rehm, Ann. Myc. **3**: 519. 1905.

Perithecia superficial, scattered, gregarious or occasionally crowded, globose or subglobose, usually collapsing from the top and becoming pezizoid, at first clothed with a scant covering of delicate, white, mycelial threads (no true hairs) which disappear with age, leaving the perithecia smooth or in very old specimens slightly rough and furfuraceous, 250–500 μ in diameter (mostly about 300 μ), varying in color from pale to deep orange, color darker in dried specimens, weathered specimens fading to pale yellow; ostiolum minute, in young specimens just visible and in older forms depressed and inconspicuous; asci cylindrical or clavate, 8-spored, 50–75 μ × 5–8 μ; spores broadly elliptical, obliquely 1-seriate or becoming crowded and partially 2-seriate, thick-walled, 1-septate, not constricted, with 1 large, conspicuous oil-drop in each cell, 10–14 μ × 4–6 μ (mostly 10 × 5 μ); paraphyses short, branched, not conspicuous. [PLATE 15.]

On decaying decorticated wood, more rarely on bark, fungi, and old hemp cloth.

TYPE LOCALITY: Mecklenburg, Germany.

DISTRIBUTION: New York to Ontario, North Dakota, California, and Louisiana.

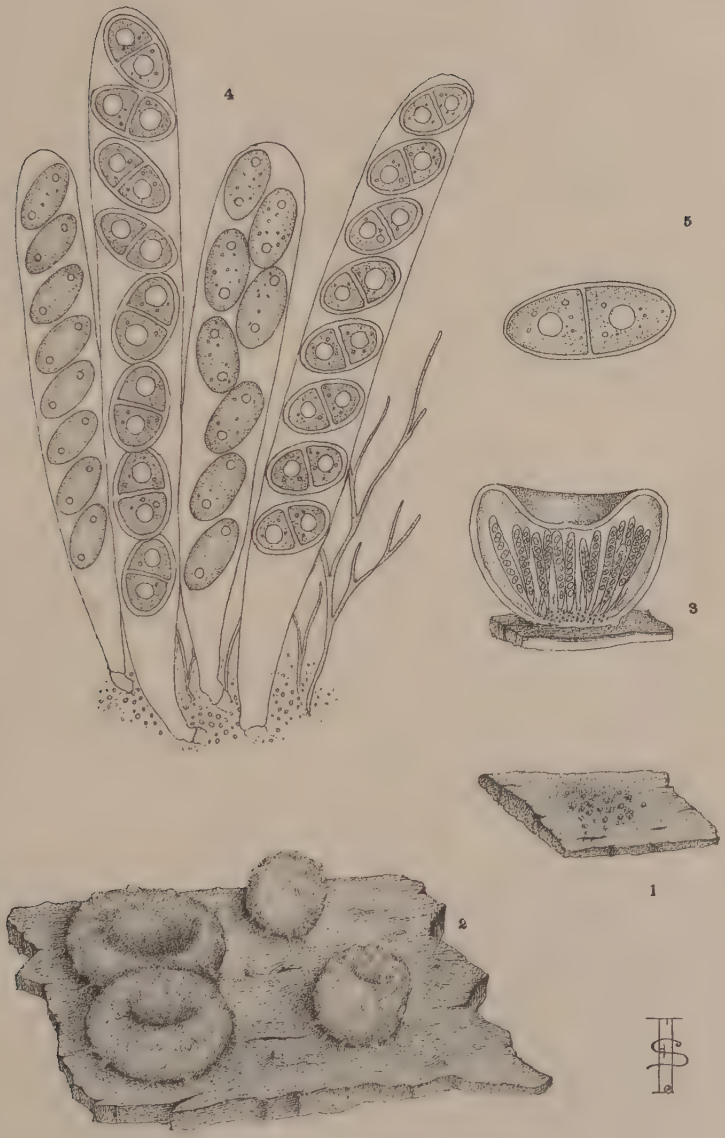
ILLUSTRATIONS: Tode, Fungi Meckl. **2**: *pl. 15. f. 122;* Bulliard, Herb. France, *pl. 410. f. 2;* Currey, Trans. Linn. Soc. **22**: *pl. 57. f. 44;* Berkeley, Outl. Brit. Fung. *pl. 24. f. 6;* Greville, Crypt. Fl. **4**: *pl. 186. f. 2.*

* The type of this species in the Ellis collection is so scant that scarcely a perithecium in good condition could be found, and it is impossible to make a thorough study of gross characters. The spores are typical of the above species.

EXSICCATI: Ravenel, Fungi Am. Exsicc. *644;* Ellis, N. Am. Fungi *774;* Wilson & Seaver, Ascom. and Lower Fungi 16. Other specimens examined: California, *Harkness;* Iowa, *Arthur, Seaver;* Louisiana, *Langlois*; Maine, *Harvey;* New York, *Atkinson, Brown, Seaver;* North Dakota, *Seaver* (various collections); New Jersey, *Ellis* (various collections); Ohio, *Hawkins, Morgan;* Ontario, *Dearness, Macoun.*

Explanation of plate 15

1. Cluster of plants, natural size.
2. Several plants, × 50.
3. Diagram section of plant, × 50.
4. Cluster of asci, × 1200.
5. One spore, × 2500.



NECTRIA PEZIZA (Tode) Fr.

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NEW YORK BOTANICAL GARDEN
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STUDIES IN PYROPHILOUS FUNGI—I. THE OCCURRENCE AND CULTIVATION OF PYRONEMA

FRED J. SEAVER

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SOIL CULTURES OF PYRONEMA OMPHALODES

STUDIES IN PYROPHILOUS FUNGI—I. THE OCCURRENCE AND CULTIVATION OF PYRONEMA

Fred J. Seaver

(With Plates 9–12, Containing Twenty-one Figures)

To the collector it is a well-known fact that there are numerous species of fungi which are known only on burnt places. While some of these forms may occur under other conditions, such occurrence is so rare as to have attracted comparatively little attention. Many popular reasons have been offered by individuals in explanation of these facts, such as the elimination of competition in the destruction of the higher plants, the presence of carbon in the soil, and that these forms really occur in other habitats and escape detection, but none of these reasons is sufficient to explain the occurrence of at least one of the plants in question. That these fungi do not occur on burnt places simply because the competition of the higher plants has been eliminated is shown by the fact that they do not, as a rule, occur on bare soil which has not been burned over. My own observation has also shown that carbonaceous materials are not necessary to the life of some of the pyrophilous fungi, and we must look for other explanations of these interesting phenomena.

The genus *Pyronema* includes several species, which, as the name implies, commonly inhabit burnt places. The occurrence of the plants of this genus on burnt ground is sufficiently common

to have suggested the name of the genus, but no one has apparently considered the matter of sufficient importance to warrant investigation.* Since the most common species of the genus, *Pyronema omphalodes* (Bull.) Fuckel, is one of the few discomycetous fungi in which sexual reproduction has been demonstrated, numerous papers have been written on this phase of the subject, but in each case the matter of the occurrence of the species is dismissed with a simple statement of the fact. Nor, so far as known, has anyone taken the trouble to cultivate the species under artificial conditions either for the study of reproductive processes or in the attempt to gain information as to the reasons for its common occurrence on burnt ground.

The plants of this genus were first encountered by the writer in 1904, when the above-named species was found to be very common on burnt places near Iowa City, Iowa. Scarcely a burnt place could be visited in and about woods in wet weather on which this species was not found to be present and often in abundance, the plants appearing on charcoal and ashes and the burnt-over soil. While the individual plants are small, ranging from one to two millimeters in diameter, they commonly occur in dense confluent masses often covering a space of several inches, and by reason of their bright color they might, in spite of their small size, be counted among the more attractive forms of fungi.

The second occurrence of this species to attract the attention of the writer was during the fall of 1906 in the propagating houses of the New York Botanical Garden, where it was found to appear on soil sterilized with steam under a pressure of ten to fifteen pounds. Here the plants occurred as usual, forming rose-colored or salmon-colored sheets over the surface of the soil, the groups of plants being surrounded by a cobweb of mycelium. Under these conditions the plants seem to thrive for a time, but

* Since this paper went to press a synopsis of the article below has come to the attention of the writer showing that some of the conclusions drawn in the present paper have been previously arrived at. Although the present work was conducted without knowledge of this previous work and the line of experimentation is different, the conclusions, so far as the work has gone, are almost identical.

Kosaroff, P. Beitrag zur Biologie von *Pyronema confluens* Tul., gleichzeitig ein Beitrag zur Kenntniss der durch Sterilisation herbeigeführten Veränderungen des Bodens. Bot. Zeit. 66: 23. 1908.

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finally mature their fruit and disappear. The species was said to occur on soil sterilized in this manner almost without exception and had been noted for several years past by those carrying on experimental work here requiring the sterilization of soils; but as the fungus usually appeared before seeds had germinated and apparently did no harm, it did little more than to arouse a passing interest. The attention of the writer was at length called to this fungus and it was identified as *Pyronema omphalodes* (Bull.) Fuckel. The occurrence of a fungus commonly associated with burnt places on soil sterilized with steam was a fact of unusual interest, since it indicated that charcoal and carbonaceous materials are not necessary to the life of this fungus as was previously supposed.

In trying to explain these facts it at once became apparent that the high temperatures to which the substrata had been subjected had something to do with the appearance of these plants under the above conditions, but whether the high temperatures had some relation to the spores of the fungus itself in stimulating them to germination or to the substrata only in preparing it for the growth of the fungus was at that time a question.

During the summer of 1907 the species was again observed in North Dakota, where it occurred on bare soil by roadsides where there was no trace of charcoal, but in places which it is easy to suspect had been fire-swept or subjected to considerable temperatures by the heat of the sun and natural conditions of sterilization.

The last appearance of these plants and the one which has prompted the study of the problem which has been made the basis of the present paper was in agar which had been inoculated with the spores of other fungi in the laboratories of the New York Botanical Garden. The appearance of this fungus, uninvited, in three different cultures at the same time in a laboratory where to my knowledge none of the plants of the genus had been studied, even from dried material, for more than two years was sufficiently mysterious to arouse interest.

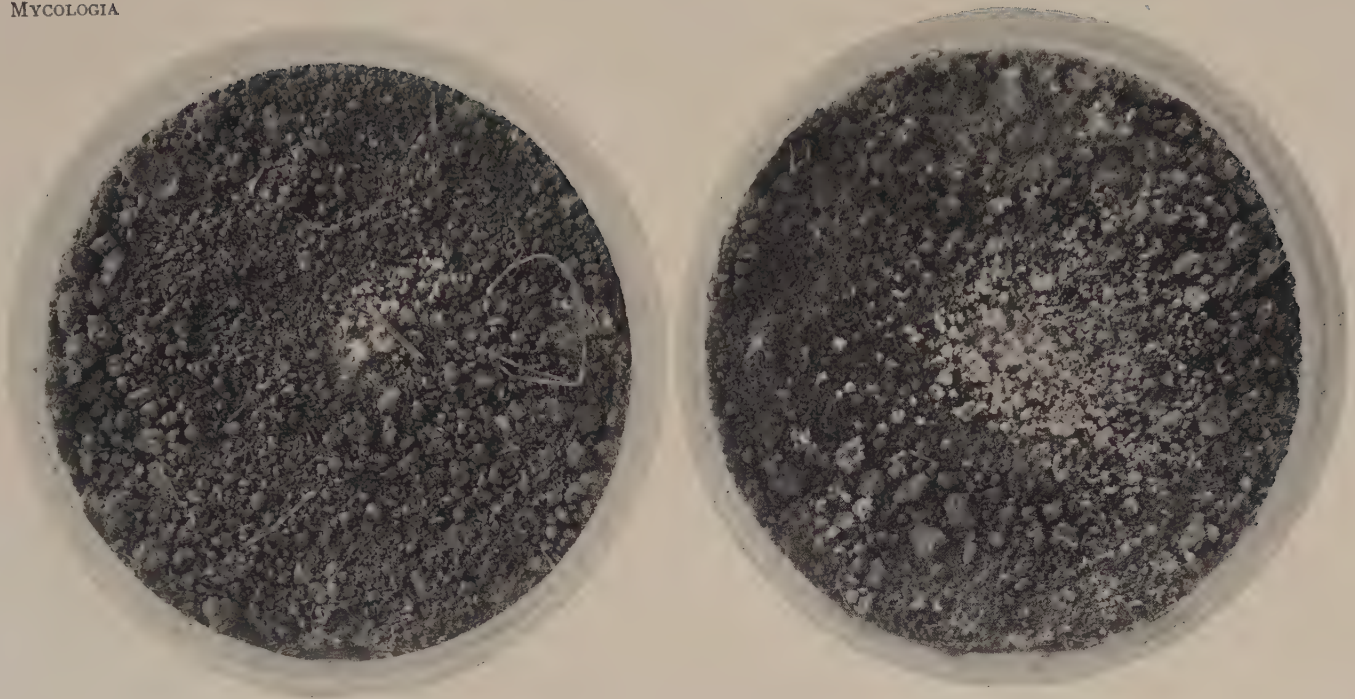
There were two possible explanations of the appearance of this fungus at this time; one that the cultures had become inoculated with the spores from the air and the other that the spores were present in the cultures and had withstood the process of steriliza-

tion. That the spores might not only be able to withstand the process of sterilization, but might even be stimulated to germination by high temperatures was suggested, since it is claimed that the spores of some of the coprophilous fungi must be subjected to the body temperature and other influences of the alimentary canal of animals in order to induce their germination.

In order to test the matter of the effect of heat on the spores of the fungus, mature ascospores were heated to various temperatures and later planted in hanging drop cultures. The heating was accomplished both with dry heat and by heating in a drop of water. In no case could the spores which had been heated to any considerable temperature be made to germinate. On the other hand, mature ascospores which had not been heated germinated readily in drop cultures, proving that if high temperatures have anything to do with the appearance of this fungus the effect is on the substratum only, the spores themselves being as sensitive to heat as are those of other species of fungi.

This species is not sufficiently common to expect that the air of the laboratory is saturated with the spores at all times, but from later experiments it is evident that these cultures were inoculated from the air. The fact that the fungus occurred in cultures in which the agar had been poured over filter paper previously heated to 110° C. for purposes of sterilization again raised the question of the relation existing between this fungus and the heating of the substratum. Cultures of agar were later tried, leaving out the filter paper, and the fungus was found to grow fully as well as in the preceding case. The luxuriant growth of this species on agar is evidence that high temperatures are not necessary in all cases to its growth. Soils sterilized with dry heat require a higher temperature to bring about favorable conditions for the growth of this fungus than are necessary for the sterilization of agar.

From our own observations and experiments there is little doubt that this fungus occurs on burnt places as a result of sterilization of such places by fire. However, it is probable that sterilization means much more than the simple elimination of competition by the destruction of bacteria and other fungi present in the soil. The nature of the changes brought about in soil by heating



SOIL CULTURES OF PYRONEMA OMPHALODES

to high temperatures is a question concerning which little is known and one which is of vital importance to the problem under consideration. While the heating of the soil destroys the fungi already present, there is every reason to believe that it prepares the way for the growth of those species which may be introduced subsequent to sterilization. The experimental work of the present paper has been based mainly on the one species, *Pyronema phalodes* (Bull.) Fuckel, but the question of the effect of the heating of soils on the production of fungi is doubtless a large one and it is the intention of the writer to extend these investigations to other forms when fresh material can be secured for experimental work.

Some of the observations in support of the above conclusion are: in its occurrence on sterilized soil the fungus usually appears at a very early date and is mature before other forms of vegetation have had time to make any considerable growth; after maturing one crop of ascocarps the fungus gradually disappears, indicating that the most favorable time for its growth is immediately after sterilization; soil sterilized, moistened and allowed to stand for a week appears to be as unfavorable for the growth of *Pyronema* as soils which have never been sterilized, notwithstanding the fact that the soil is entirely free from other forms of vegetation so far as the eye can detect.

In its occurrence in nature on burnt ground, no notes have been made as to the relative time between the burning of the substratum and the appearance of the fungus. This would doubtless depend upon conditions of moisture. A place having been thoroughly sterilized would remain so until the return of moisture, when the *Pyronema* avails itself of the favorable conditions of sterilization and moisture and matures its crop of spores. So far as can be recalled, this species has been found on burnt places only when bare and apparently devoid of other forms of vegetation, indicating that it appears soon after burning or soon after the return of moisture to the burnt places.

In its occurrence on agar, the *Pyronema* grows rapidly, covering the surface of the agar in a three-inch petri dish in about four days. All of the cultures have been slightly contaminated with other fungi in the center of the dish, but fruit has not been

produced when the *Pyronema* has been planted in cultures already thoroughly contaminated with other fungi.

A fresh culture on agar in which the mycelium was radiating equally in all directions was contaminated by placing a drop of water rich in bacteria directly in front of the advancing mycelium. In a short time the water had evaporated, leaving only the contaminated spot. The mycelium continued to grow on both sides of the spot but refused to cross the infected area. Later, it gradually surrounded this area, which was apparently unfavorable to its growth.

In no case have I failed to produce an abundant crop of fruit in three to six days on soil sterilized under high steam pressure or with dry heat at a high temperature when such soils have been inoculated with the spores of the fungus. Indeed, such conditions are so favorable that it is difficult to prevent the fungus from invading such places even when not inoculated. On the other hand, in no case have I been able to produce more than a beginning of growth on unsterilized soil. Soils sterilized at low temperatures often produce a scant growth of ascocarps, which are, for the most part, devoid of the normal color.

The observation is made by Dr. R. A. Harper* that this plant also occurs on damp, well-rotted leaves where there has been no fire. I can account for this only on the ground that the leaves have been previously sun dried and subjected to natural conditions of sterilization, for in my experiments here every attempt to grow this fungus on unsterilized materials has failed. It is quite probable that other conditions of sterilization might give the same results as those produced by fire, but this point has not yet been demonstrated.

METHODS OF CULTIVATION FOR STUDY

The cultivation of fungi under artificial conditions is comparatively easy when we are able to meet the conditions in the laboratory under which they normally occur in nature. The apparent preference of this species for conditions of sterilization render it unusually favorable for cultivation under artificial conditions.

* Sexual Reproduction in *Pyronema confluens* and the Morphology of the Ascocarp. Ann. Bot. 14: 321. 1900.

The rapidity of growth, together with the fact that the sex organs in *Pyronema* are the largest known among the ascomycetes, should render the species of this genus of unusual interest to instructors who desire such material for study in the classroom, when the ease with which they may be artificially cultivated becomes known. The length of time during which the spores and mycelium will keep their vitality in the laboratory is a question which time alone will answer. When once the plant is started it can be cultivated generation after generation with perfect success, enabling the student to trace every step in the life-history of the plant from the germination of the spores to the production of the sex organs and, a few days later, the mature ascocarps.

The existence of sex organs in this plant has been known for many years, but it is only recently that Dr. R. A. Harper has demonstrated that these are actually functional. His study, however, was based on material collected under natural conditions, he having made no attempt to cultivate the species on nutrient media. The fact that this can be done would render the species as available for regular laboratory study as are the reproductive organs of some of the common algae.

If it is desired to study the reproductive organs from gross material, and agar is available, this is one of the best media to use, since the development of the plant can be studied in culture from day to day by placing it under the low power of a compound microscope. The surface of the agar is smooth and transparent, so that we may detect the earliest appearance of the forming fruit and these may be mounted on a slide in a drop of agar, thus eliminating grit and sand which might be present in material grown on soil. Much care must be taken to get the plants at a very early stage, for immediately after fertilization each cluster of sex organs is surrounded by the tissues of the developing ascocarp, which obscure the details of the reproductive organs.

Soil which has been heated to a high temperature is apparently more favorable for the production of the sex organs and ascocarps in large numbers than agar. In a pot of sterilized soil the fruit is produced on the pot as well as on the soil and can quite easily be removed for study. Since soil is always available and most nearly approaches the natural conditions for the growth of

the species, it is probably the most practical medium to be employed.

If plants are desired for sectioning, soft materials, such as broken leaves, may be placed on the soil and sterilized. In this case the fruit is formed in clusters on the leaves and soil. The pieces of leaves may then be removed, imbedded, and sectioned in the ordinary way, or the plants may be scraped off from the leaves and mounted and studied from the gross material.

SUMMARY

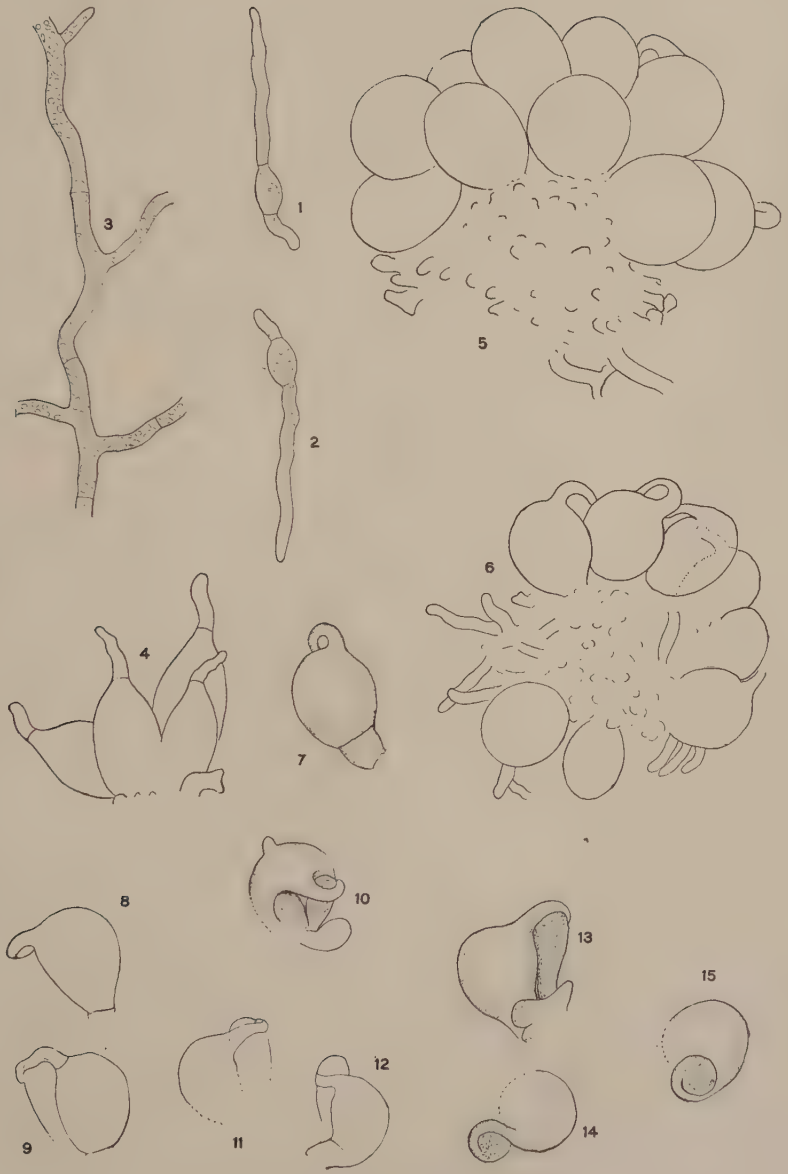
1. *Pyronema omphalodes,* which normally occurs on burnt places, can be successfully cultivated on nutrient media, producing sex organs on the fifth or sixth day and mature ascocarps in about ten days from the time of the planting of the spores.

2. This fungus will produce an abundance of fruit on soil or leaf-mold which has been sterilized by heating to high temperatures (110° C. or over), but refuses to produce fruit or any considerable mycelium on unsterilized soil or soil heated to low temperatures (less than 95° C.).

3. Sterilization by steam serves the same purpose as sterilization with dry heat, provided the soil is sterilized under sufficient pressure (5 lbs. or over). Soil sterilized under low pressure (2 lbs. or less) produces fruit only sparingly.

4. The time required to produce fruit on soil, as well as the abundance of the fruit itself, varies with the temperature to which the substratum has been subjected. Soil sterilized at 95° C. has produced no fruit; soil sterilized at 110° C. produces a fair quantity of fruit; while soil sterilized at 135°–145° C. produces fruit in abundance. The length of time of the application of the heat also has some influence.

5. Sterilization of soil by heat apparently brings about some change in the soil other than the simple elimination of competition in the destruction of bacteria and other fungi, which changes appear to be of vital importance in the cultivation of fungi which normally grow on burnt soil.



PYRONEMA OMPHALODES

EXPLANATION OF PLATES

PLATE IX

Two pots of soil, the left unsterilized, the right sterilized with dry heat at 140° C. for 15 hrs. Both were planted with seeds of pea, the sterilized pot soon becoming thoroughly infected with *Pyronema omphalodes* (Bull.) Fuckel, the unsterilized pot remaining uninfected. × ⅔.

PLATE X

Soil cultures, the left unsterilized, the right sterilized with steam under a pressure of 5 lbs. for 1–2 hrs. Both were innoculated with the spores of *Pyronema omphalodes* at a point near the center of the culture. The unsterilized culture produced no fruit and a very scant growth of mycelium surrounding the point of inoculation. The sterilized culture produced an abundant growth of mycelium and abundant fruit. × ½.

PLATE XI

Soil cultures, the left sterilized with dry heat at 110° C. for 1 hr., the right sterilized at 145° C. for 1 hr., the latter producing mycelium and fruit in much greater abundance than the former. × ½.

PLATE XII

1–2. Germination of spores of *Pyronema omphalodes* in hanging culture after 20 hrs.
3. Portion of mycelium drawn from culture grown on agar.
4. Portion of a cluster of oogonia at an early stage.
5. Cluster of oogonia drawn from material grown on agar.
6. Cluster of oogonia partially teased out.
7–13. Figures of oogonia and antherida drawn from material grown on agar.
14–15. End views of oogonia and antheridia drawn from culture material.

All the figures on this plate were sketched with the aid of a camera lucida, and are magnified 500 diameters.

NEW YORK BOTANICAL GARDEN.

[Reprinted from Mycologia, Vol. I., No. 6, November, 1909.]

ASCOMYCETES AND LOWER FUNGI—FASCICLE III

Guy West Wilson and Fred Jay Seaver

51. Botryosphaeria Quercuum (Schw.) Sacc. Syll. Fung. 1: 456. 1882.

Sphaeria Quercuum Schw. Schr. Nat. Ges. Leipzig 1: 40. 1818.

The species is apparently very variable and numerous synonyms have been sighted. For more complete synonymy see Ellis and Everh. N. Am. Pyrenom. 546. Bronx, N. Y. City, spring, 1907. F. J. S.

52. Cenangium furfuraceum (Roth) Sacc. Syll. Fung. 8: 565. 1889.

Peziza furfuracea Roth, Cat. Bot. 2: 257 *pl. 9, f 3.* 1800.
Dermatea furfuracea Fries, Summa Veg. Scand. 362. 1849.
Encoelia furfuracea Karst. Myc. Fenn. 1: 218. 1871.

Rather common in N. Dakota on dead branches of *Corylus* sp. Coll. spring, 1908. F. J. S.

53. Cercospora Davisii Ellis & Everh. Proc. Acad. Nat. Sci. Phil. 1891: 89. 1892.

On leaves of *Melilotus alba* Desv., Fayette, Iowa, July 2, 1909. G. W. & D. D. Wilson.

Rather abundant in some patches of the host but on the whole not common.

54. Hypocrea Richardsoni Berk. & Mont.; Berk Grevillea 4: 14. 1875.

Common on dead branches of *Populus tremuloides* Michx. Fargo, N. Dakota, spring, 1908. F. J. S.

According to Schrenk (Bull. Torrey Club 21: 388) this is a *Corticium.*

55. PHYLLOSTICTA LABRUSCAE Thüm, Pilze des Wein. 189. 1878.

Guignardia Bidwellii (Ellis) Vala & Ravaz, Bull. Soc. Myc. Fr. 8: 63. 1892.

On leaves of *Vitis vulpina* L., Fayette, Iowa. July 2, 1909. G. W. W.

According to M. E. Roze (Bull. Soc. Myc. Fr. 14: 24. 1892) *Phoma uvicula* Berk. & Curtis and *Phyllosticta viticola* Thümen represent stages in the development of this fungus.

56. HELMINTHOSPORIUM GRAMINUM Rabenh. Herb. Viv. Myc. II. *332*. 1856.

On leaves of *Hordeum vulgare* L., Fayette, Iowa, June 29, 1909. G. W. W.

Locally rather destructive to barley and quite prevalent the present season.

57. HYPOCREA CITRINA (Pers.) Fries, Summa Veg. Scand. 383. 1849.

Sphaeria citrina Pers. Obs. Myc. 1: 68. 1796.

On dead branches of *Tilia americana* L. while still on the tree, especially occurring where the bark is broken, Fargo, N. Dakota, 1907–8. Observed in this locality only on basswood.

58. HYSTEROGRAPHIUM KANSENSE Ellis & Everh. Erythea 2: 22. 1894.

On bark of *Quercus* sp., Mt. Pleasant, Iowa, summer, 1905. F. J. S.

The specimens have been compared with the type of this species and conform well in all respects.

59. MICROSPHAERA ALNI (Wallr.) Salmon. Mem. Torrey Club. 9: 129. 1900.

Alphitomorpha alni Wallr. Ann. Wett. Ges. 4: 237. 1819.

On leaves of *Syringa vulgaris,* Bronx, N. Y. City, autumn, 1908. F. J. S.

For more complete synonymy see Salmon, l. c.

60. NECTRIA EPISPHAERIA (Tode) Fries, Summa Veg. Scand. 388. 1845.

Sphaeria episphaeria Tode, Fungi Meckl. 2: 21. 1791.

On old sphaeriaceous fungi, Fargo, N. Dakota, 1907–8. F. J. S.

61. NECTRIA SEMINICOLA Seaver, Mycologia 1: 21. 1909.

On seeds of skunk cabbage, *Spathyema foetida,* autumn, 1906. F. J. S.

The material issued under this number is cotype. The species has been observed during the present season, 1909, on similar habitat.

62. PERONOSPORA CALOTHECA de Bary; Rabenh. Herb. Viv. Myc. II. *673.* 1858.

On *Galium boreale* L., Fayette, Iowa, July 1, 1909. G. W. W.

Local but where present rather abundant. While other species of *Galium* grow with the infected one, the fungus appears to be confined to the one host.

63. PERONOSPORA PARASITICA (Pers.) Fries, Summa Veg. Scand. 493. 1849.

Botrytis parasitica Pers. Obs. Myc. 1: 96. *pl. 5, f. 6.* 1796.
Peronospora Dentariae Rabenh. Fungi Europ. *86*; Fl. 42: 436. 1859.

On *Dentaria laciniata* Muhl., Fayette, Iowa, May 14, 1908. G. W. W.

Not abundant on the present host, at least locally.

64. PERONOSPORA TRIFOLIORUM de Bary, Ann. Sci. Nat. IV. 20: 117. 1863.

On leaves of *Astragalus carolinianus* L., Fayette, Iowa, June 5, 1908. G. W. W.

Rather an uncommon species which is locally abundant on this host. The form on *Astragalus* may be distinct from that on *Trifolium* and *Medicago.*

65. PHYSALOSPORA AURANTIA Ellis & Everh. N. Am. Fungi *2355*; N. Am. Pyrenom. 304. *pl. 27, f. 1–6.*

On leaves of *Astragalus* sp., Kulm, N. Dakota. Coll. J. F. Brenckle.

The specimens distributed here conform well with the type.

66. PLASMOPARA PYGMAEA (Unger) Schröter; Cohn, Krypt. Fl. Schles. 3^1: 234. 1886.

Botrytis pygmaea Unger, Exanth. Pfl. 172. 1833.

Peronospora pygmaea Unger, Bot. Zeit. **5**: 315. 1847.

On *Anemone caroliniana* Walt., Fayette, Iowa, June 9, 1908. G. W. W.

When present this little fungus covers large areas of the host with a very dense growth of conidiophores.

67. PLEONECTRIA BEROLINENSIS Sacc. Michelia **1**: 123. 1878.

Nectria Ribis Niessl, Verh. Nat. Ver. Brumm. **2**: 114. 1865 (homonym).

Pleonectria Ribis (Niessl) Karst. Medd. Soc. Fauna Fl. Fenn. **5**: 42. 1879.

On cultivated currants, Fargo, N. Dakota, summer, 1908. F. J. S.

68. RHYSOTHECA VITICOLA (Berk. & Curtis) G. W. Wilson, Bull. Torrey Club **34**: 407. 1907.

Botrytis viticola Berk. & Curtis; Berkeley, Jour. Hort. Soc. London **6**: 289. 1851 (hyponym).

Peronospora viticola Casp. Monatsb. K. Preuss. Akad. Wiss. **1855**: 331. 1855 (hyponym); de Bary, Ann. Sci. Nat. IV. **20**: 125. 1863.

Plasmopara viticola Berl. & De-Toni; in Sacc. Syll. Fung. **7**: 338. 1888.

On *Vitis vulpina* L., Fayette, Iowa, June 25, 1909.

This destructive fungus appears as spots on the leaves as a fruit rot, or involves both stem and leaf of the new growth covering them with a dense mould-like growth and causing some hypertrophy.

69. RHYTISMA SALICINUM (Pers.) Fries, Syst. Myc. **2**: 568. 1822.

Xyloma salicinum Pers. Tent. Disp. Fung. 5. 1797.

On leaves of *Salix* sp., Kulm, N. Dakota, 1908. Coll. J. F. Brenckle.

70. SEPTORIA SCROPHULARIAE Peck, Ann. Rep. N. Y. St. Mus. **28**: 57. 1879.

On leaves of *Scrophularia marylandica* L., Fayette, Iowa, July 2, 1909. G. W. W.

71. SPHAERELLA FRAGARIAE (Tul.) Sacc. Syll. Fung. **1**: 505. 1882.

Sphaeria Fragariae Tul. Ann. Sci. Nat. IV. **5**: 112. 1856.
Stigmatea Fragariae Tul. Sel. Fung. Carp. **2**: 288. *pl. 31.* 1863.
Ramularia Tulasnei Sacc., Michelia **1**: 536. 1879.
Ramularia Fragariae Peck, Ann. Rep. N. Y. St. Mus. **34**: 30. *pl. 3, f. 12, 15.* 1883.

Conidia on leaves of *Fragaria virginiana* Duchesne, Fayette, Iowa, July 2, 1909. G. W. W.

72. SYNCHYTRIUM AECIDIOIDES (Peck) n. n.

Uredo accidioides Peck, Ann. Rep. N. Y. St. Mus. **24**: 88. 1872.
Uredo Peckii Thümen, Myc. Univ. 538. 1876.
Synchytrium fulgens decepiens Farl. Bull. Bussey Inst. **2**: 229. 1879.
Synchytrium decepiens Farl. Bot. Gaz. **10**: 240. 1885.

On *Falcata comosa* (L.) Kuntze, Fayette, Iowa, July 3, 1909. G. W. & D. D. Wilson.

73. TAPHRINA JOHANSONII Sadeb. Jahrb. Hamd. Wissensch. Anst. **10**: 74. 1893.

On capsules of *Populus tremuloides* Michx., Fayette, Iowa, May 18, 1909. G. W. & D. D. Wilson.

The bright yellow color of the infected capsules makes this a very conspicuous fungus. Not common but where present the trees were thoroughly infected.

74. URNULA CRATERIUM (Schw.) Fries, Summa Veg. Scand. 364. 1849.

Peziza craterium Schw. Schr. Nat. Ges. Leipzig 1: 117. *pl. 1, f. 7–11.* 1818.

Fayette, Iowa, May, 1908. G. W. W. & H. H. Strauss.

Locally common on fallen branches in woodlands.

75. XYLARIA HYPOXYLON (L.) Grev. Fl. Edin. 335. 1824.

Clavaria Hypoxylon L. Sp. Pl. 1182. 1753.

Sphaeria Hypoxylon Pers. Obs. Myc. 1: 20. 1796.

On rotten wood, Bronx, N. York City, 1907. F. J. S.

N.Y. Bot. Gard.

Some Plant Diseases: Their Cause And Treatment

FRED J. SEAVER

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SOME PLANT DISEASES: THEIR CAUSE AND TREATMENT.*

Plants like animals are subject to disease, and the knowledge of the cause and treatment of these diseases is one of the branches of botanical work which has grown, until today it is a science in itself. This is, to a large extent, due to the fact that the government, through its Agricultural Colleges, is appropriating annually large sums of money to be expended in the investigations of the cause and treatment of the diseases of the cultivated plants; and well it may afford to do so, for to be able to combat successfully a single plant disease would bring in return to the country in a single year much more than all that is spent for this purpose during the same length of time.

Almost every plant which grows has its characteristic disease and some plants are afflicted with many, so that the subject is a very extensive one and I can do nothing more this afternoon than to call your attention to a few of the most common plant diseases, give you some idea of their causes, and a few of the methods which have been employed for their treatment.

Before taking up the subject of plant diseases proper, I want to mention briefly, by way of comparison, one of the chief causes of animal diseases. As you all doubtless know, many of the diseases of the animal body, speaking more particularly of the

* An illustrated lecture delivered in the Museum building of the New York Botanical Garden, October 30, 1909.

human body, are caused by minute organisms which live, many of them move, grow, and reproduce within the tissues of our bodies. These organisms are known in a general way as bacteria.

The bacteria are the smallest known living organisms and can be studied only with the aid of a powerful microscope, and for this

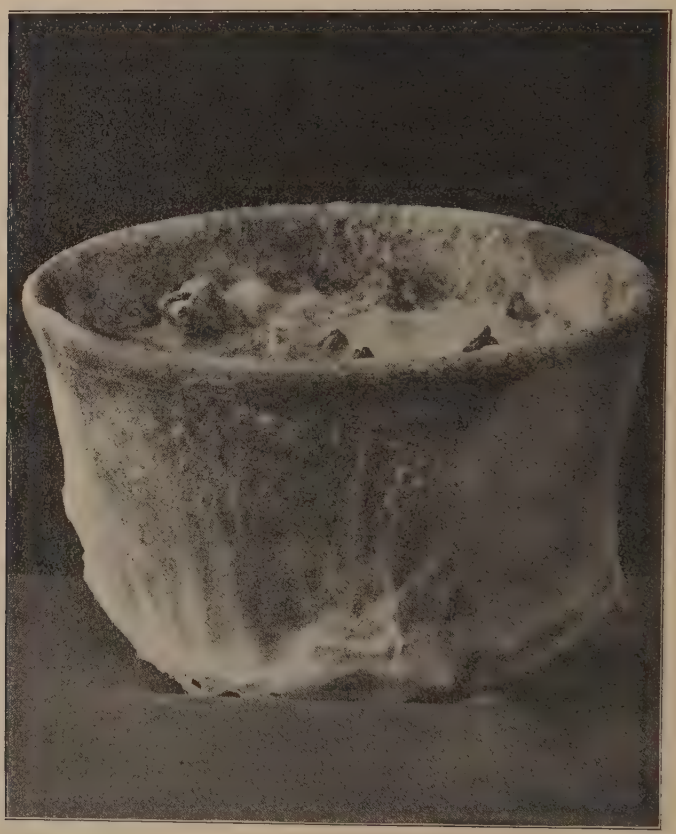

FIG. 33. The mycelium or growing phase of a fungus.

reason the science of bacteriology is of comparatively recent origin. The reproduction of the bacteria is a very simple process: an individual attains mature size and divides or breaks into two; each of the offspring again attains mature size and the process is repeated. One of the chief characteristics of the bacteria is their physiology,

or the way in which they live. Every plant which has green coloring matter (chlorophyll) is able to make its food from the simple materials which are present in the air and in the water of the soil. Those living organisms which are destitute of green coloring matter are unable to make their own food and are therefore dependent upon other organisms for their food supply. The

Fig. 34. The fruit of a fungus on an oak stump.

bacteria belong to this latter class and there are two ways in which they may obtain their nourishment: (1) They may prey upon other living animals or plants when they are said to be parasites or (2) they may live upon decaying matter when they are known as saprophytes.

The fact that many diseases of the human body are known to be caused by bacteria is likely to give to this group of plants (for plants they are) a reputation which they do not rightfully deserve, for these organisms are really of great service to the world. In the commercial world they are made use of in many ways: the process of fermentation and the manufacture of alcohol is dependent upon the action of bacteria; in the cheese industry they play an important part, and are employed in the manufacture of many dyes. Perhaps one of the chief services of the bacteria is in their relation to decay. The process of decay is a very important one, and were it not for the action of bacteria in reducing complex materials to their simple form the surface of the earth would become encumbered with the remains of dead animals and plants. In this alone, they atone for any evil which may be charged to them. The fact that a few forms have become parasitic upon the human body, bringing about disease and death, is of vast importance to us, but so far as this group of plants is concerned it is only an incidental matter, for there are comparatively few which act in this manner.

There is another group of lower plants which is of vast importance to us on account of their relation to animal and plant diseases, more especially to plant diseases. These plants are known as fungi, mildews or moulds. The fungi bear about the same relation to plant diseases which bacteria hold to diseases of animals. While many diseases of the animal body are caused by bacteria, comparatively few are caused by fungi. On the other hand, while many diseases among the vegetable kingdom result from fungi, comparatively few are known to be caused by bacteria. The fungi may be considered one of the chief causes of plant diseases.

From a physiological point of view the fungi are identical with bacteria; *i. e.*, they are devoid of green coloring matter and are therefore dependent upon other organisms for their food, and like bacteria they may be either parasitic or saprophytic. The chief differences between fungi and bacteria are in their structure and reproduction. Instead of isolated, minute, motile bodies the fungi consist of a mass of delicate, simple or branching threads.

These threads are many times more delicate than the finest hair, in fact, they are so delicate that they can scarcely be seen with the unaided eye. However, when they occur in large numbers these threads give somewhat the appearance of very delicate cotton. Such a mass is known as the mycelium (fig. 33) or growing phase of the fungus.

The fungi are propagated by means of special reproductive bodies known as spores. The spores may be very simple bodies, and among the lower forms are often borne in chains—like strings of beads, or they may be more complicated and there is no limit to the variety of forms which may be assumed by the reproductive bodies of this group of plants. Among the higher fungi special structures are developed for holding the spores. Such structures as toadstools, puffballs, and bracket-fungi (fig. 34) represent only the spore-bearing phase of fungi whose mycelium or growing phase may extend often for many feet into the substratum on which they are borne.

Saprophytes Which May Become Parasites.

The blue mould is a fungus with which we are all familiar, and one which occurs normally as a saprophyte on decaying materials of various kinds, especially on decaying fruit. Often, on removing the cover from a can of preserved fruit, a bluish scum will be found over its surface. This is the blue mould, and the spores of this fungus are produced in such great abundance that it is impossible to expose suitable materials to the air for any length of time without having them infected with this plant. While normally a saprophyte, this fungus may under proper conditions become a parasite, and is often the cause of great damage to ripe fruit, especially to fruit which is kept in storage. This fungus, however, is unable to attack fruit unless it is injured in some way and experiment has proved that if stored fruit is carefully handled so as to prevent bruising the damage from this cause is very much reduced.

The fish mould is another fungus which normally lives as a saprophyte on decaying materials in water. It is doubtful if this plant is able to attack healthy fish, but if the bodies of these

animals are injured or the scales broken the fungus enters the wound and has been known to destroy thousands of fish in a single season. This is one of the comparatively few cases of diseases of the animal body which are caused by fungi. We have some examples even among man, ringworm representing such a disease.

Harmful Parasites.

Indian Corn and Its Diseases.

I want now to call your attention to some of the diseases of the cultivated plants which are caused by fungi. The Indian corn is strictly an American crop and is, without exception, the chief of crops in this country at the present time. Corn is made use of in two ways: (1) As an animal food and (2) as a human food direct. Its use as a human food is of minor importance, since it is found more profitable to use this grain as a live stock food. In this way it is converted into beef and pork which is sent to our cities and more congested centers of population to be used as a food product. Anything which tends to reduce the corn-crop affects the price of meat, and we are all influenced by it whether we are interested directly in the cultivation of corn or not.

Like most other cultivated plants the corn-plant is subject to many diseases. The one which is of especial importance is that known as the corn-smut. Corn-smut first becomes visible as large puffball-like outgrowths which replace the healthy grains. This however represents only the fruit of the fungus. In the fall of the year these bodies which are known as smut-balls burst and the soot-like spores within fall to the ground in showers. There they lie until spring, when they germinate and produce a tiny thread. If perchance this comes into contact with a young corn-plant it penetrates its tissues and there grows for a time unseen. In the late summer when the corn-plant begins to send up large quantities of food to be stored in the seed for the nourishment of the young corn-plant, the fungus avails itself of this favorable opportunity and uses this food on which to mature its

own spores, and we find a smut-ball where we should have had a healthy grain.

Since the corn-plant is infected mainly through the soil one of the best methods of controlling this disease is to prevent the infection of the young plants which is best accomplished by the rotation of corn with other crops. If corn is grown year after year on the same soil the disease becomes worse and worse until a very large part of the crop is destroyed.

FIG. 35. Witches' broom of black spruce, a disease caused by a fungous parasite.

SMUT OF OATS.

Another crop of considerable importance in this country is the oat-crop. If we should walk through a field of oats about harvest time and look closely at the grain we would find occasionally a head in which all of the healthy seeds are replaced by a black mass of spores similar to those found in the corn-smut. At first sight it might appear that the loss from this disease is too

slight to deserve attention. When we consider that it takes as much nourishment to mature a head of smutted oats as one of healthy grain, and that this disease causes an annual loss in the United States estimated at $15,000,000, we begin to realize its economic importance. The life history of the oat-smut is very similar to that of the corn, but its methods of infection are quite different. The spores are not produced in such great quantities and the chances of the young plants becoming infected by the spores in the soil are comparatively slight. In thrashing the grain the spores of the smut are thoroughly distributed among the healthy seeds and, being very small, readily cling to the husks which surround the seed of the oat. If these seeds are planted, the seed of the host and the spores of the fungus germinate together and, being in close contact, the young plant is easily infected.

The greater part of the loss occasioned by oat-smut is unnecessary for this is one of the diseases which is very easily controlled. It has been found that it is possible to treat the seed of oats with formaldehyde or hot water in such a way as to destroy the spores of the fungus which may cling to the seed without injuring the life of the seed itself, and since the main source of infection of this disease is through the seed this means of control has proved very effective.

Wilt Disease of Watermelon and Cotton.

In places where the watermelon is cultivated extensively much trouble has resulted from a disease commonly known as the watermelon-wilt. This disease is characterized by the wilting of the foliage which results in the death of the plants. In the watermelon as in other higher plants the water necessary to supply the forming fruit and the growing leaves as well as that lost by evaporation through the leaves is taken up from the soil and conducted through the stems to the place where it is to be used or evaporated. If we examine a section of the stem of a watermelon vine we find numerous large ducts which serve this purpose. Those who have made a study of the watermelon-wilt disease have found that this is caused by a fungus which grows

on the inside of the stems in such a way that the mycelium of the fungus clogs up the water ducts and shuts off the water-supply which results in the wilting of the leaves and death of the plants.

The cotton-plant should also be mentioned in this connection, since this plant is attacked by a wilt disease similar in its effects to that of the watermelon. And strange to say, this disease is caused by a variety of the same fungus which attacks the watermelon.

The best solution of the wilt problem seems to be in the cultivation of resistant varieties of the plants affected. This may be done by the selection of natural strains of varieties, by the production of hybrids, or by the selection of the seed from the stronger plants of any variety. Much progress has been made in the cultivation of resistant varieties of cotton.

Rust of Wheat and Other Plants.

It is not necessary to mention the importance of wheat as a food product. This grain thrives best in rather cool climates. In portions of the northern United States and Canada wheat growing is one of the principal industries. As harvest time approaches in districts where wheat is relied upon as one of the chief farm products the condition of the grain with reference to wheat-rust is watched with the greatest of solicitude, for this disease has been known to destroy the entire crop.

Wheat-rust is a very old offender and has been known since ancient times. The ancients were very superstitious and believed that this disease was caused by evil spirits and the remedy proposed by them was to frighten away the evil spirits by making a loud noise. The cause of wheat-rust is very well known at the present time, but the remedy proposed by the ancients is probably about as effective as anything which has been suggested in more recent times.

This disease is caused by a fungous parasite and one of the most perfect parasites with which we have to deal, and at the same time one of the most difficult to control. Three distinct stages are represented in the life history of this fungus, the spring phase, the summer phase, and the autumnal or winter phase.

The spring phase occurs on the leaves of the barberry bush, a shrub which is cultivated for hedges. The summer and winter phases occur on the leaves and stems of wheat or other grain.

If we examine the leaves of the barberry bush in the spring of the year we will find that they are covered with minute pockets, each of which is filled with a mass of golden-yellow spores. These spores are blown about by the wind, and if they fall on the leaves or stems of the wheat-plant and weather conditions are suitable they germinate and in a short time we have produced there a mass of rust-red spores which represent the summer phase of this fungus. These spores are again blown about and germinate immediately producing other infection. Late in the summer we find, in place of the red spores, a mass of black spores, which represents the autumnal phase of the rust and is commonly known as the black rust. The black rust represents only a more advanced stage of the red rust. The black spores are especially adapted to tide over the unfavorable conditions of the winter season. They live over winter on the old straw or in the ground. In the spring of the year each germinates and produces a number of minute spore-like bodies which are ready to return to the barberry bush and begin the life cycle of this fungus anew.

Since the barberry bush plays an important part in the life history of this disease one precaution which can be taken is to destroy these bushes which may occur in fence rows in close proximity to wheat fields. One of the most hopeful means of eventually controlling this disease is in the cultivation of rust-resistant varieties of wheat by a process of seed selection and it remains to be seen what the outcome of this line of attack will be.

Many different plants are attacked by rusts of various kinds. The cedar-apple rust is one of considerable importance. While very different in general appearance the cedar-apple rust is closely related to the wheat-rust. This disease is represented by two stages which occur on the cedar-tree and on the leaves of the crab-apple respectively. The cedar-apple stage is characterized by gall-like swellings often an inch in diameter and the trees are often heavily loaded with these apple-like growths (fig. 36). People have been known to plant cedar-apples with the hope of producing

cedar-trees, but they have no more relation to the cedar than an insect-gall has to the plant on which it is produced. To control this disease the planting of cedar-trees and apples near together should be avoided.

FIG. 36. Gall-like growth of cedar-apple rust.

"There is no loss without some gain," and while the rusts attack many cultivated plants, bringing about immense losses, they also attack plants which are troublesome weeds in many places and doubtless assist to some extent in holding these weeds in check.

THE POTATO AND ITS DISEASES.

The potato represents one of our staple foods and there is probably no plant which is more susceptible to diseases of various

kinds than this one. The first of these diseases which I will mention is that commonly known as scab. The name is well chosen for the disease is characterized by the rough, scaly appearance of the tubers. This diseased condition results from the presence of a parasitic fungus.

The potato is not propagated by means of seed but by the tubers themselves. If diseased potatoes are planted the resulting crop is sure to be infected. Potato-scab is transmitted through the tubers which are used for propagation but may also be transmitted through the soil. The selection and treatment with formaldehyde of the tubers to be used for planting has been shown to be quite effective in controlling this disease.

One of the most destructive diseases of the potato is the early blight which makes its appearance as small, white fungous growths on the leaves, often destroying a whole crop before its presence has been detected. In places where the potato is largely relied upon as an article of food, famine has been known to follow the destruction of this disease. The blight not only causes death of the plants but brings about rotting of the tubers as well.

Spraying with proper fungicides* has been found effective in the control of this disease if taken in time. From a series of experiments in New York state spraying has been found to result in a saving of more than twenty dollars per acre. If these experiments were extended throughout the state with equal results the saving would amount to $8,000,000 after deducting cost of spraying.

Diseases of the Orange.

The sooty-mould is a fungus which injures the orange to such an extent that the losses from this disease in Florida are estimated at $50,000 annually. This trouble is a combination of an insect and a fungus. The insect attacks the orange and the fungus appears on the remains of the insect, and together these pests have succeeded in disfiguring the orange to such an extent that its market value is greatly reduced.

* Bordeaux mixture, a solution of lime and copper sulphate, is one of the best known fungicides. This is sprayed over the foliage of the plants and serves as a preventative against the attacks of fungi.

There are numerous fungi which occur as parasites on scales and other insects. The destruction of the fungus only lends encouragement to the insects on which they occur. If the insects are destroyed both will disappear, since the fungus cannot live on the plant tissues. At the present time many experiments are being conducted especially in Florida with a view to using such fungi for combating the insect pests. This method of the employment of the natural enemies to combat plant diseases has, up to the present time, given remarkable results and much more is hoped for it in the future.

Ergot of Rye.

The ergot of rye is a fungous disease which has several economic bearings. The ergot which replaces the healthy grain consists of a very hard slender body about one-half inch in length and represents the resting stage of a fungus. This fungous body is poisonous and when eaten by cattle causes a characteristic disease known as ergotism. When present in rye flour in sufficient quantities it causes trouble among people; it also causes a slight reduction of crop. These fungous structures are gathered and, having medicinal properties, are sold as an official drug under the name of ergot.

Diseases of Peaches, Plums and Cherries.

The leaf-curl is one of the most common diseases of the peach. As a result of this disease the leaves become curled, distorted and twisted. They finally become discolored and fall. The plum-pocket is caused by a fungus similar to that of leaf-curl. Plum-pocket causes the fruit to become much enlarged, hollow and deformed, the outside of the pocket being entirely covered with the fruit of the fungus. Witches' brooms are sometimes caused by a similar parasite (fig. 35). The black-knot is another disease of fungous origin which attacks both plums and cherries, causing the branches to become enlarged, deformed and blackened by the fruit of the fungus.

Leaf-curl can be controlled by spraying with proper fungicides

about the time the buds are opening in the spring. Plum-pocket and black-knot are both best controlled by pruning back the diseased branches. If the tree is badly infected with black-knot the whole plant should be cut down and burned.

Insect-Galls.

Insect-galls include those injuries by insects which result in abnormal swellings of the stems or leaves or other parts of the plant (fig. 37). The adult insect deposits its eggs in the young parts of plants, and the sting of the adult or the hatching of the young or both together furnish the stimulus necessary to bring about this abnormal and often very conspicuous growth. From their general appearance insect-galls are likely to be confused with fungous diseases. Since these injuries are of insect origin their consideration belongs more properly to the entomologist.

Parasites which are Beneficial to the Host.

We ordinarily think of a parasite as something which is harmful to the host on which it occurs. This is usually the case, but there are some parasites which are not harmful, and on the other hand are actually beneficial to the plants on which they live. We have an interesting example of this among the various members of the pea family. If we should remove a pea-vine or bean-plant from the ground we would find the roots often covered with numerous swellings resembling miniature potatoes. These swellings are caused by a parasite which in this case is one of the bacteria.

Plants need nitrogen in order that they may grow. While nitrogen is present in great quantities in the air most plants are unable to use it in this form but require it in the form of compounds as it exists in the soil. The nitrogen compounds in the soil become very much reduced by excessive cultivation, so that it is often impossible to produce a healthy crop, and soils are then said to be worn out. The bacteria which grow on the roots of various members of the pea family are able to fix free nitrogen from the air in such a way as to make it available for the host

on which they grow. For this reason the members of this family are able to thrive on soils which are unsuitable for other plants. Not only do these bacteria supply the nitrogen compounds necessary for the host on which they grow but the soil is enriched by the growth of such plants.

Fig. 37. Insect-galls on a branch of swamp-oak.

The value of clover as a fertilizer has long been known but it is only comparatively recently that the reasons for this have been worked out, and the value of such plants as rotation crops is fully recognized at the present time.

Parasites Among Higher Plants.

Not only do the lower plants become parasitic upon the higher plants, but some of the higher plants have also adapted themselves to living as parasites. One of the most common illustrations of such a plant is the dodder. This is produced from a seed, but when the young plant has attained a height of about an inch it attaches itself to the stems of other plants, sends minute sucking organs into the stem of its host and throughout the remainder of its life draws its nourishment from this source. Cultivated plants are often attacked by this parasite but as the cause is evident the dodder is controlled in the same manner as other troublesome weeds.

Fred J. Seaver.

STUDIES IN PYROPHILOUS FUNGI—II.

CHANGES BROUGHT ABOUT BY THE HEATING OF SOILS AND THEIR RELATION TO THE GROWTH OF PYRONEMA AND OTHER FUNGI

FRED J. SEAVER AND ERNEST D. CLARK

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Fred J. Seaver and Ernest D. Clark

(With Plates 24–26, Containing 6 Figures)

(From the Laboratories of the New York Botanical Garden)

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I. Introduction

Our observations noted in previous papers as to the occurrence of *Pyronema* on burned-over or heated soil had been previously noted by Kasaroff, who in this connection states that this striking phenomenon could not be explained on the assumption that the fungus had survived the heating, a subsequent infection being a much more likely explanation. The results of numerous experiments are not wholly consistent but point to certain conclusions.

Kasaroff thought that the absence of growth on unheated-soil is not due to the fact that through the process of heating more material necessary to the fungus is set free but rather that the unheated-soil contains constituents which render the growth of the fungus impossible, which constituents are destroyed by heat-

* Studies in pyrophilous fungi—I. Occurrence and cultivation of Pyronema, was published in Mycologia 1: 131–139. 1909.

ing. It was not found possible by washing with water to wholly remove from the unheated-soil the unfavorable constituent but the soil extract contained the substances of unheated-soil which are unfavorable to the growth of *Pyronema*. Experiments with heated-soil showed that the properties favorable to *Pyronema* growth which were developed in the soil by heating may be removed from the soil by washing and in other ways. The reason for this is not clear. By boiling the extract of an unheated-soil its unfavorable properties may be partially removed. An extract of heated-soil cannot, to any great extent, render an unheated-soil a favorable nutrient medium for *Pyronema* but this may be accomplished by the addition of kainite, while the addition of charcoal, coal, and coke in various forms yields no beneficial results.

II. Toxin Theory

The conclusions of Kasaroff as to the reasons for the failure of *Pyronema* to grow on unheated-soil while it thrives on heated-soil seem to indicate that the unheated-soil contains a substance toxic to *Pyronema* which substance is destroyed by heat. This explanation is strengthened by the fact that other investigators have found in soils substances toxic to the higher plants, which substances inhibit the growth of such plants even in the presence of an abundance of food material.

The idea that there are toxic organic materials in soils arising from previous plant growth or otherwise, is rather a new conception but one which has been advanced and confirmed by Schreiner and his collaborators in the last few years. According to these conceptions there are definite, organic compounds in the soil, which, in the case of four substances, have been isolated, crystallized and analyzed, thus proving their composition and constitution. Some of these substances were proved to be harmful to plants by water-culture experiments, and all of them belong to types of substances that may well prove toxic to different kinds of plants on further investigation.

Such organic bodies may arise in a variety of ways, by root excretions from the growing plants, by simple decomposition and oxidation of the plant remains in the soil, and by bacterial action, etc. When one remembers that the plant body contains besides

carbohydrates and proteins, the following more or less complex substances; alkaloids, glucosides, tannins, hydrocarbons, resins, etc., it is not difficult to imagine how compounds toxic to the plant might well arise either directly or through bacterial action, slow oxidation or other deep-seated changes. Schreiner has shown that the growth of a plant in a solution makes that solution rather toxic to the growth of the same plant in the same medium because of the throwing off of toxic organic substances, rather than the depletion of the food supply by the growth of the plant.

All of this shows that in questions of soil fertility for certain plants, we must not only consider what necessary food materials are present but also determine, if possible, whether there are any toxic substances present which would check plant growth even in the presence of an abundant supply of organic and inorganic food materials.

In order to test the toxin theory with reference to the growth of *Pyronema,* an extract of unheated-soil was prepared by adding four liters of distilled water to two kilograms of unheated-soil. This mixture was stirred frequently and allowed to stand for some time and later filtered and used for the treatment of heated-soil.

On November 11, 1909, a series of experiments was conducted in which three pots of soil heated to about 160° C. for about two hours (S^1, S^2, and S^3) were used, with a pot of similar soil unheated as a control (C). Pot (S^1) and control (C) were treated with distilled water. Pot (S^2) was treated with extract of unheated-soil prepared in the above manner, the mixture having been allowed to stand with frequent stirring for two hours. Pot (S^3) was also treated with extract of unheated-soil on the following day, the mixture having been allowed to stand for twenty-four hours instead of two as in the preceding experiment. Each was inoculated with *Pyronema.*

On November 23, (S^1) and (S^2) showed fair growth of *Pyronema* especially on the pots, but at this time no fruit had appeared, while (S^3) showed good growth of mycelium and fruit. Control (C) gave negative results as usual.

Other experiments similar to the above were later conducted. In each case the heated-soil treated with the extract of

unheated-soil prepared in various ways proved to be fully as favorable, as culture media for *Pyronema,* as similar soil treated with distilled water, the variations being no more marked than would be expected in experiments of this nature. Heated-soil treated with distilled water and that treated with the extract of unheated-soil both gave good results.

These results indicate that if the failure of *Pyronema* to grow on unheated-soil is due to toxic constituents present in the soil these substances are not soluble in water, at least not in sufficient quantities to render extracts of such soils toxic to *Pyronema.*

III. PYRONEMA GROWTH A FOOD PROBLEM

It had often been noted in the course of our experiments that heated-soil when watered had a peculiar and characteristic pungent odor, together with the rather pleasant odor of caramel. It had also been noted that heated-soil when watered, often assumed a darker color than the same kind of soil unheated and watered in the same manner. This change of color was not universal but frequently occurred and probably depended upon the intensity of the heat.

Having repeatedly failed to show that the extract of unheated-soil had any toxic influence on the growth of *Pyronema,* we were inclined to abandon the toxin theory as an explanation of the failure of this fungus to grow on unheated-soil. It then occurred to us to reverse our experiments and try the effect of heated-soil extract with unheated-soil (p. 115). On December 2, a five-inch pot of soil was heated to a temperature of 175° C. for about two hours. This soil was then cooled and the pot placed over a filter in an extraction apparatus arranged for this purpose. Distilled water was poured into the pot until it percolated through the soil and filtered into the bottom of the extraction apparatus. A similar pot of the same kind of soil unheated was treated in the same manner. The extracts of the heated-soil and unheated-soil made in this manner were very different; the extract of the heated-soil was of a bright amber or reddish-brown color and very clear, while that of the unheated-soil was clear or slightly clouded but with no trace of the color characteristic of the heated-soil extract. The odor of the heated-

soil extract was also very characteristic, approaching that of the heated-soil itself, while the unheated-soil extract had the odor of ordinary moist earth.

When concentrated by evaporation, the residue from the heated-soil extract was of a dark brown color and possessed a very strong odor of caramel.

Other extracts of local soils were made with similar results. When heated at low temperature the color of the soil extract is often very pale, while the same soils when reheated at a higher temperature yield a much more highly colored extract, which indicates that high temperatures are necessary factors in producing a highly colored extract.

The production of an extract from heated-soil of apparently different composition from that obtained from unheated-soils and which possessed the odor characteristic of soils most favorable to *Pyronema* growth, suggested the possibility that after all we were dealing with a *food* problem, notwithstanding the fact that this had apparently been disproved by Kasaroff.

In order to test the effect of heat on other than local soils a sample of North Dakota soil was obtained through the kindness of Professor H. L. Bolley of the North Dakota Agricultural College. A sample of this soil was heated and an extract made as in previous experiments. The results were similar in every way except that the extract was of a much darker color (reddish-brown), a result which would naturally be expected by reason of the large amount of organic material in the soil. A more detailed account of the results of these tests will be given in Section VII.

Extracts of a Massachusetts soil sent by the kindness of Mr. M. G. Clark did not differ materially from extracts of local New York soils.

We should call attention here to the correlation between the temperatures necessary for the production of a strong or highly colored extract and those necessary in order to render the soil favorable to the growth of *Pyronema*. It has already been noted in a previous paper that the higher the temperatures to which the soils are heated (so far as our experiments had gone), the more favorable are the conditions for the growth of the fungus. We

have since found that the higher the temperature to which the soil is heated (up to 200° C.) the more favorable are the conditions for the production of a highly colored extract. This would at least suggest that the formation of this extract is directly concerned in the growth of *Pyronema*.

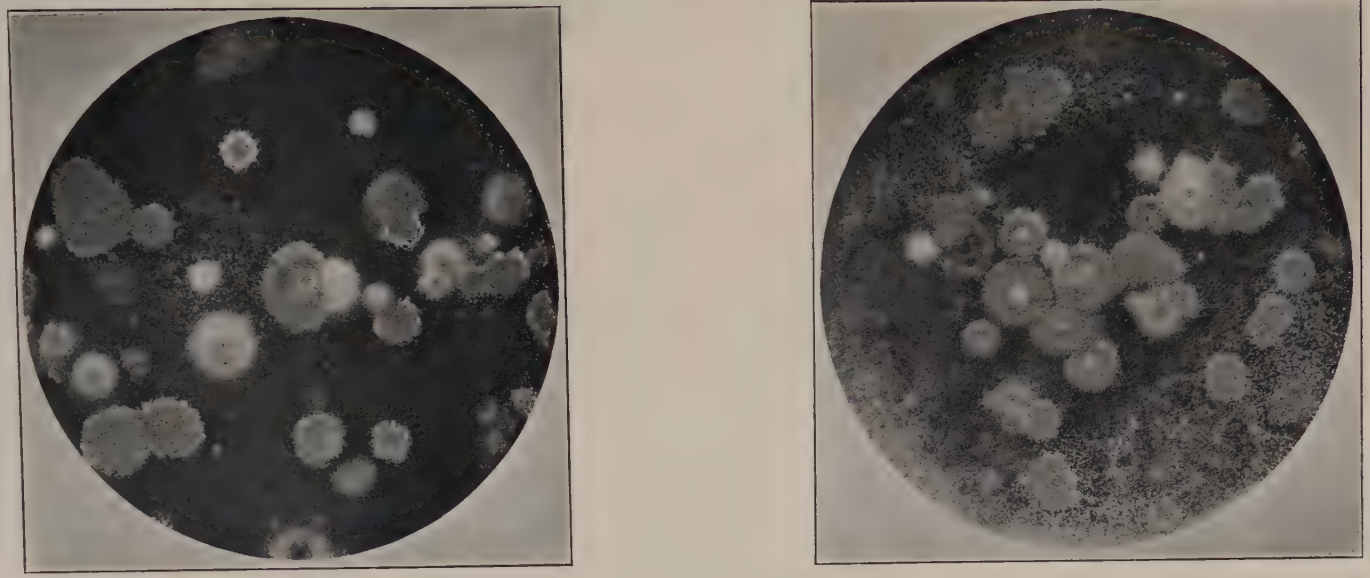
IV. Biological Experiments with Soil Extracts

A number of extracts of heated soils were made and placed in tightly closed bottles, with no intention, however, of guarding against the possibility of air infection by fungi. Several of the extracts were evaporated down to various stages of concentration and all kept for experiment and study.

In a short time it was observed that a number of these extracts were infected with the mycelium of a fungus. In most cases the mycelium consisted of globose colonies varying from a few millimeters to a centimeter in diameter. Each consisted of a mass of mycelial threads radiating from a central point and apparently originating from a single spore. As the plants became older the mycelium became more fluffy and in some cases almost entirely filled the bottles containing the extract while in other cases the extract seemed to be less favorable for their continued growth. These colonies usually started near the bottom of the bottle, entirely immersed in the solution.

Some of this mycelium was removed from the bottles and placed on filter paper saturated with the extract. In several cases the fruit of *Pyronema* soon appeared and in some cases was produced in abundance, while in a few experiments no fruit was produced. From these experiments it became evident that the fungus which was infecting our extracts was *Pyronema*, as we had previously suspected and as the mycelium itself indicated.

So favorable are the heated-soil extracts as culture media for *Pyronema* that it has been found almost impossible to keep the extracts for any length of time in our laboratories without having them thoroughly infected with the fungus (*pl. 25, f. 2*). The same fact has already been noted with reference to heated-soil itself, this being so favorable as a nutrient medium for *Pyronema* that it is difficult to keep the fungus from invading



Two cultures of heated-soil extract self infected with fungi of various kinds, *Penicillium*, *Verticillium*, *Mucor* and *Pyronema*. Controls containing the extracts of the same soil before heating and exposed under the same conditions were entirely free from fungous infection.

these substrata when exposed in our laboratory where the spores are present from previous experiments.

As stated above, the extract of North Dakota soil is much darker in color than those of local soils, a result which would be expected since the soil itself is much blacker by reason of the large amount of organic matter present. We have shown by our experiments that the color of the extract is an index to the amount of soluble substances they contain. It would naturally follow that the extract of North Dakota soil is much richer and therefore a more favorable culture medium for *Pyronema* than the extract of the other soils studied, as our experiments have later shown.

In order to run a parallel test on the unheated-soil extract and heated-soil extract, three Petri dishes were partially filled with the highly colored extract of North Dakota soil and three similar dishes filled with the extract of the same soil unheated. These were placed side by side and loosely covered, allowing abundant opportunity for air infection. In a few days, the extract of the heated-soil showed an abundant infection consisting of numerous surface colonies of various kinds of fungi and a large number of immersed colonies of what appeared to be *Pyronema*. In about a week, two of the dishes showed abundant growth of *Pyronema*, the mycelium forming a very thin but tough membrane over the surface of the extract and the fruit being produced in great abundance over its surface, especially around the outsides of the culture (*pl. 24*). Although the mycelium of *Pyronema* had invaded our extracts continually these were the first cultures in which the fruit was produced in the extract. The controls containing the extract of unheated-soil showed no signs of infection by fungi of any kind.

The abundant infection of heated-soil extracts with *Pyronema* while the extracts of the same soil unheated remained uninfected, is strong evidence that the fungus appears here on account of the large amount of soluble food material liberated in the soil through the process of heating.

Numerous attempts to render unheated-soil favorable to *Pyronema* growth by the addition of heated-soil extract have failed to yield the expected results. Assuming that the extract contains food material for *Pyronema* it has been difficult to account for

these failures. There are however two possible explanations: (1) that the unheated-soil contains a toxin which retards the growth of the fungus even in the presence of abundant food material, which toxin is destroyed by heat, thus rendering our problem a double one; and (2) that the nature of the food material itself is changed by the action of the unheated-soil.

Our experiments indicate that these failures to render unheated-soil favorable for this fungus are due in part to the fact that the nature of the food material is changed when this is introduced into unheated-soil. This is shown by the fact that if a pot of unheated-soil is saturated with a concentrated extract of heated-soil (reddish-brown in color) and allowed to stand for a few days, it is found that the extract has almost entirely lost its color. This result may be due to chemical combination or to the adsorptive phenomena shown by many finely divided materials such as animal charcoal, which will completely decolorize large volumes of solutions containing dyes, etc. Quantitative studies of extracts treated in this manner show that the soluble materials have been reduced to approximately the same amount contained in extract of unheated-soil. This taking out of solution of the soluble materials in heated-soil extract when added to unheated-soil, seems to account for our failure to render unheated-soil favorable to *Pyronema* in this manner, but it is possible that there are other factors concerned. This is further suggested by the following observation: While it has been impossible to render unheated-soil favorable to *Pyronema* by the addition of heated-soil extract, heated-soil which is watered with the extract of other heated-soil is much more favorable than the same kind of soil treated with distilled water, as is shown by the fact that both mycelium and fruit of *Pyronema* are produced in much greater abundance on the heated-soil watered with the extract (*pl. 26*).

V. Heated-Soil and Its Extracts as Nutrient Media for Fungi

In a previous paper, attention was called to the fact that while heating of soil destroys fungi present at the time of heating, it prepares the way for the growth of those species which are intro-

duced subsequent to heating. This conclusion was drawn from the observation of such forms as *Verticillium, Fusarium,* and species of various other genera of the imperfect fungi which gain entrance to the soil through the planting of seeds. The growth of such fungi was much more abundant on heated- than on unheated-soil.

Our later experiments with heated-soil extracts confirm the above observation. In addition to *Pyronema* noted above, these extracts are immediately attacked by *Penicillium, Mucor, Aspergillus,* and a number of undetermined, imperfect fungi, which grow in abundance, entirely covering and filling the extracts, especially the stronger ones, while the extracts of the same soils unheated show no fungous growth whatever. The only way in which we have been able to preserve extracts of heated-soils in our laboratory is by sterilizing and tightly sealing them in bottles. In this way we have been able to preserve them in excellent condition, while if not sterilized and tightly sealed they are soon disintegrated through the action of bacteria and fungi (*pl. 25, f. 2*).

In our studies of the Iowa Discomycetes it has been observed that about five per cent. of the species of this group reported from Iowa occur only on burned places. That such habitats are unusually favorable to the growth of saprophytic fungi is beyond question.

It is likely that many of the beneficial results obtained through the sterilization of soils, which effects have been attributed to the destruction of harmful fungi and bacteria in the soil, are due more to the chemical changes accompanying sterilization than to the sterilization itself.

VI. Distillates from Heated-Soil Extracts

Some heated-soil extract of a brownish color was distilled to one half of its original volume and the distillate collected. The residual solution in the flask had the rather pleasant odor of the heated-soil extract but the distillate had the pungent odor which is also present in the original extract. Both the distillate and the liquid in the distilling flask were acid to litmus. We thought that possibly we had been able to separate the toxic from the non-toxic acid substances by their difference in volatility and for this reason

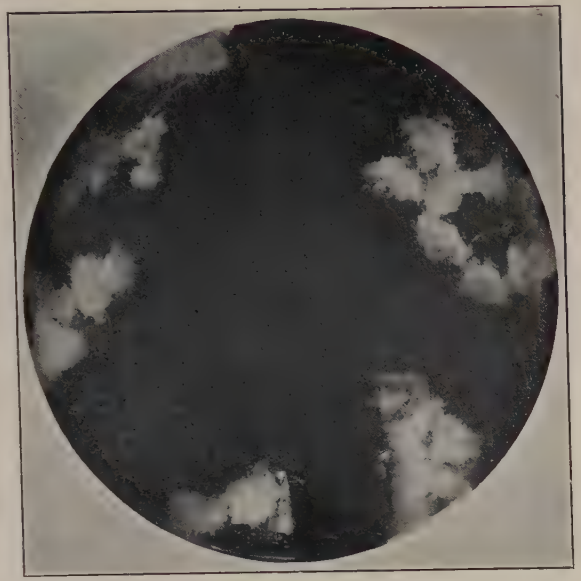
inoculated both liquids with the spores of *Pyronema*. In a week, the flask containing the dark-colored distillation residue was filled with the mycelium, while the other flask also had a considerable growth of *Pyronema*, the latter flask and liquid being perfectly transparent, with the silvery clumps of mycelium resting on the bottom of the flask (*pl. 25, f. 1*). Thus it seemed that distillation did not cause any appreciable separation of the substances in the extract, *i. e.*, judging from its effect on the growth of *Pyronema*.

VII. Chemical Studies of Soil Extracts

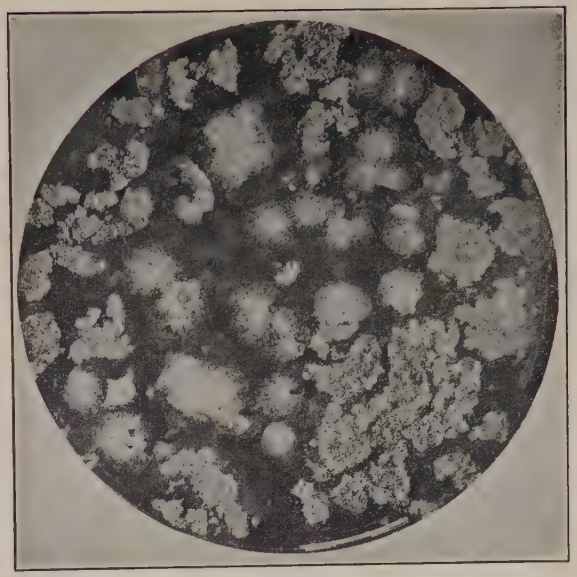
(*a*) Quantitative

As already noted, the color, odor, and general appearance of heated-soil extracts indicate that the composition of such extracts must be considerably different from that of extracts of unheated-soils. We decided to investigate first the quantitative differences between the extract of heated-soil and the same kind of soil unheated. The extracts which we analyzed were made by percolating the soils in 2 kg. samples with 2 liters of distilled water and taking 50 c.c. of the first liter of extract to come through, as the sample of the extract to be analyzed. The 50 c.c. samples of the extracts were evaporated to dryness in platinum dishes, dried at 108° to constant weight and this weight recorded as total solids. The residues were carefully ashed at a low, red heat, dried and weighed again, this weight recorded as inorganic matter and the difference between this weight and the weight of the total solids recorded as organic matter. We are aware that this method of determination of organic matter by difference of the weight obtained before and after ashing is not strictly accurate, but for the comparative purposes of this work this loss of weight may be used as a satisfactory measure of the organic matter present.

Determinations were made in this manner upon samples of New York soil, Massachusetts soil, and North Dakota soil. Since it had been noted that the percolation of an extract of heated-soil through an unheated-soil reduced and finally removed its color and again made it an unfavorable medium for *Pyronema* growth, we repeated this treatment with an extract of heated-soil whose composition was known and determined the change in com-



1. Colonies of *Pyronema* growing in the distillate of heated-soil extract.



2. Heated-soil extract infected with floating colonies of various kinds of fungi.

position after it had been acted on by the unheated-soil. The results of our work on the quantitative relations of soil extracts are presented in the following table:

INCREASE OF SOLUBLE MATTER IN SOIL UPON HEATING.

		Total solid matter. Per cent.	Organic matter. Per cent.	Inorganic matter. Per cent.
New York soil (1)	Unheated soil extract	0.036	0.017	0.019
	Heated-soil extract	0.138	0.094	0.044
New York soil (2)	Unheated-soil extract	0.038	0.022	0.016
	Heated-soil extract	0.239	0.179	0.060
Massachusetts soil	Unheated-soil extract	0.016	0.008	0.008
	Heated-soil extract	0.249	0.197	0.052
North Dakota soil (1)	Unheated soil extract	0.100	0.050	0.050
	Heated-soil extract	1.080	0.807	0.273
North Dakota soil (2)	Unheated soil extract	0.101	0.037	0.064
	Heated-soil extract	0.986	0.758	0.228

DECREASE OF SOLUBLE MATTER IN HEATED-SOIL EXTRACT BY TREATMENT WITH UNHEATED-SOIL.

		Total solid matter. Per cent.	Organic matter. Per cent.	Inorganic matter. Per cent.
New York soil (2)	Before treatment	0.239	0.179	0.060
	After treatment	0.031	0.019	0.012
North Dakota soil (3)	Before treatment	0.756	0.576	0.180
	After treatment	0.100	0.052	0.048

In examining these results one is struck by the enormous increase of soluble matter produced by heating. This increase varies somewhat with different soils, depending upon the amount of organic matter present, the length of time heated, and the intensity of the heat, but in general the soluble matter in extracts of heated-soils is from six to ten times that contained in the extracts of the same soils before heating. The increase in the organic matter is greater than that in the inorganic matter, but still the latter is evidently increased several times. With such large amounts of both organic and inorganic matter made available in soils by heating, one can understand the preference of certain plants for places which have been burned over. It is interesting to note that where the heated-soil extract was percolated through and allowed to stand for a time with the unheated-

soil, the heated-soil extract was reduced to almost exactly the same condition as the extract of the same soil before heating.

(*b*) QUALITATIVE

We next undertook to investigate the nature of the substances that seemed to make heated-soil extracts favorable culture media for *Pyronema* and other fungi. The pungent odor of the extracts of heated-soil together with the pronounced acidity towards litmus suggested acids, while the dark color and caramel odor suggested carbohydrates or their decomposition products. The following tests were made on heated-soil extracts before being evaporated:

Litmus paper—red.
Lead acetate—brownish precipitate.
Silver nitrate—slight precipitate (not soluble in ammonia).
Barium chloride—slight precipitate.
Alcohol—slight precipitate.
Calcium hydroxide—slight precipitate.
Ether—does not dissolve color of solution.
Molisch test—positive.

This same extract when evaporated to one fiftieth its original bulk showed the same reactions in every case except that they were far more pronounced. This concentrated extract also caused a strong reduction of Fehling solution while the blanks were negative. All of the above tests were repeated many times and the results were practically always in accord with those described above.

When unheated-soil extracts were tested in exactly the same manner, the acidity was slight as shown by litmus, barium chloride gave a slight precipitate (owing to sulphates), and silver nitrate also gave a slight precipitate wholly soluble in ammonium hydroxide (probably owing to chlorides), while all the other tests were negative.

From the qualitative tests just described we are inclined to believe that upon heating to about 160° to 180° C., the organic matter in the soil undergoes some deep-seated changes probably oxidative in nature, favored by the high temperatures, which give us the water-soluble products of an acid character producing the dark-colored solutions. The acidity of heated-soil extracts

and the heavy precipitates obtained with lead acetate, silver nitrate, and calcium hydroxide, might well be due to the presence of organic acids. The positive Molisch test indicates carbohydrates or their decomposition products, while the strong reducing action on Fehling solution would seem to confirm the assumption that carbohydrate substances are present. It is not at all impossible that the partially disintegrated cellulose of the bodies of plants previously growing on the soil, would be broken up into still smaller fragments of the original enormous molecule, and that these smaller fragments would still retain some of their carbohydrate characteristics together with the added one of acidity.

We next examined the ash of the North Dakota heated-soil extract in a qualitative manner to discover if possible the nature of the inorganic substances in the extract. The ash of the North Dakota soil was used for the reason that this was obtained in considerable quantity and that the extract of this soil was unusually favorable as a culture medium for fungi, probably owing to the large amount of organic matter originally present in the soil. The ash of the *unheated* North Dakota soil was pure white and soluble in water (100 c.c.). Upon analysis the ash was found to consist principally of the sulphates of sodium, potassium, magnesium and calcium; we were however able to find scarcely a trace of phosphates. About one-half of the ash of the extract of *heated* North Dakota soil was found to be soluble in water. In the soluble portion of the ash, sulphates of potassium, sodium, magnesium and calcium, etc., were found. In the insoluble part of the ash, we found principally calcium sulphate with some manganese, iron and traces of phosphates, etc. Calcium is thus seen to be present in considerable quantities in the extracts of heated- and unheated-soils and it may be, from the well-known stimulating and protective properties of calcium toward plants, that this element along with the organic matter helps to give heated soils some of their striking properties.

Just as this work was being brought to a close we received, upon request, a copy of an article (in galley proof) by Professor T. L. Lyon, who is publishing the results of his investigations on the effects of steam sterilization upon soils. With steam heat he found the same great increase of soluble matter over

unheated-soils that we found in the case of dry heat at 180° C. He also calls attention to the same disappearance of this soluble organic matter when soils were allowed to stand after steam sterilization, that we had noted in our work on *Pyronema*. All this shows that either dry or steam heat may cause very important changes in soils and that it is to the effect of these changes on plants, as well as to the destruction of bacteria, etc., that we must ascribe the cultural results often noted in our experiments with heated-soils.

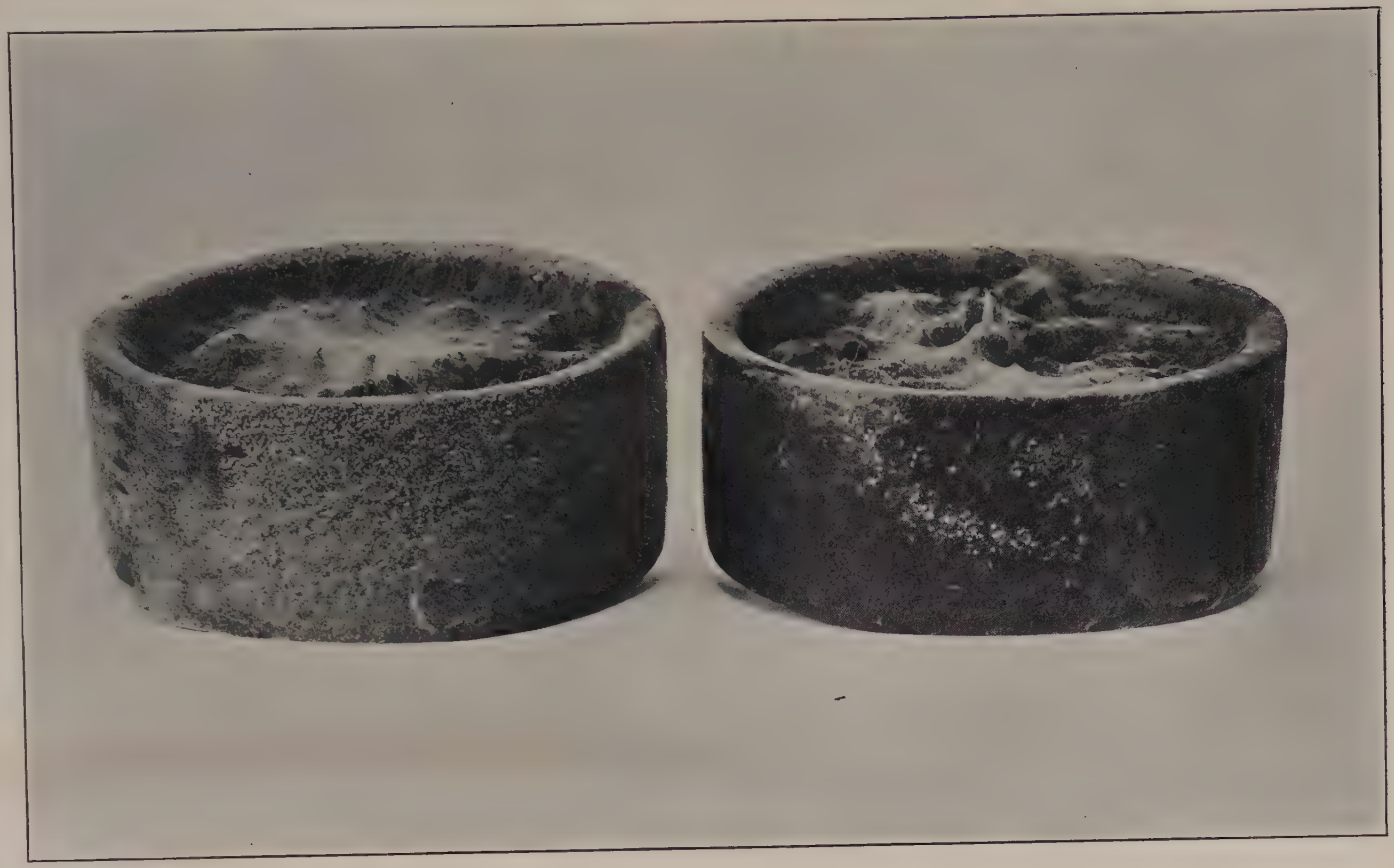
VIII. Products of Dry Distillation of Soil

In order to see if the heating of a soil would drive off substances toxic to *Pyronema*, we filled a combustion tube with soil, put it in the furnace, fitted to the tube a smaller glass tube opening under a receiver of distilled water and heated the soil. Steam came over first and then more and more of a yellowish oil which was partially suspended in the water and partially formed a scum on the surface. The oily substance had an intensely irritating and nauseating odor like that of an old, stale pipe and recalled pyridine or its allies. The liquid in the receiver was alkaline to litmus. All of this seemed to indicate pyridine bases. We watered some heated-soil with this liquid and inoculated it with *Pyronema*. In a week, the growth on this soil was as good as that on the control watered with distilled water.

The soil left in the tube was black. This was watered with distilled water and inoculated with the spores of *Pyronema* but proved to be unfavorable to its growth, although some mycelium was produced.

IX. Identity of the Fungus

The fungus which we have been cultivating in the laboratory had been determined by us as *Pyronema omphalodes* (Bull.) Fuckel, although its appearance in the laboratory differed slightly from specimens of this species previously observed by us in the field. In nature the ascocarps of this species give rise to dense, confluent masses in which it is difficult to recognize the individual ascocarps, while in the laboratory the plants are thickly gregarious but not confluent to the extent that they are in nature. It therefore occurred to us that the species might be distinct.



Both pots of soil heated, the one to the left watered with heated-soil extract and the one to the right with distilled water ; to show the improvement of heated soil for *Pyronema* by the addition of more extract.

In order to prove the identity of the species, in the spring of 1908 a pile of dead grass and leaves was raked together on the ground and burned, giving rise to a burnt place similar to those on which *Pyronema omphalodes* (Bull.) Fuckel was known to occur. As soon as the first rain occurred after the burning of this material a few of the plants from the laboratory were placed in the ashes and on the ground where the fire had been. In about ten days a good growth of *Pyronema omphalodes* (Bull.) Fuckel was found, the plants occurring in confluent masses as usual. These plants were taken into the laboratory and inoculations made from them on heated-soil. These at once produced mycelium radiating out from the point of infection and later produced an abundance of fruit, the ascocarps being scattered as is usually the case in laboratory grown material.

Some of the laboratory plants show rather well developed, hyaline, septate hairs, although these are not a conspicuous character. The color also varies much from bright rose or salmon to almost white. The paler plants are usually those produced on less favorable substrata. The fungus has doubtless been described under several names.

SUMMARY

1. Contrary to the statement of Kasaroff, our experiments have failed to show the presence of a soluble, toxic substance in unheated-soil which will retard the growth of *Pyronema* when applied to heated-soil.

2. Heating the soil to a high temperature brings about chemical changes indicated by the following: (*a*) The extract of heated-soil is of a bright amber or reddish-brown color and possesses a characteristic odor while the extract of unheated-soil is colorless and almost odorless, (*b*) the amount of soluble material in the extract of heated-soil is increased to approximately* six to ten times that of the extract of the same soil unheated.

3. The materials rendered available by the heating of the soil serve as food for *Pyronema,* as is indicated by the following: (*a*) The conditions necessary for the production of a highly colored extract in soil are the conditions most favorable to the growth

* The exact increase will vary with the soil and manner in which it is treated, temperature, length of time heated, etc.

of *Pyronema,* (*b*) the extract of heated-soil is itself so favorable as a culture medium that it is at once attacked by the fungus while the extract of the same soil unheated remains uninfected, (*c*) heated-soil watered with the extract of another heated-soil is much more favorable to *Pyronema* growth than similar soil watered with distilled water, the former producing mycelium and fruit in much greater abundance.

4. Distillation of heated-soil extract does not remove the properties favorable to *Pyronema,* both the colorless distillate and the highly colored distillation residue being favorable to its growth, the distillation residue, however, appearing to be more favorable than the distillate.

5. Excessive heating of soil in a combustion-tube renders it unfavorable to *Pyronema* growth. The distillate has a very offensive odor but is apparently neutral to *Pyronema* growth when applied to heated-soil.

6. It has been impossible to render unheated-soil favorable to the growth of the fungus by the introduction of the extract of heated-soil, this being apparently due to the fact that the nutrient materials in the extract are rendered insoluble by the action of unheated-soil.

7. Not only is the extract of heated-soil a favorable nutrient medium for *Pyronema,* but for other fungi as well, indicated by the fact that the extract is attacked by fungi of various kinds.

8. Soil subjected to steam or dry heat (either in a closed oven or by burning over the surface of the soil), becomes a very favorable nutrient medium for fungi of various kinds, by reason of the large quantity of food material rendered available through the heating of the materials in the soil.

We wish to acknowledge our indebtedness to Dr. W. J. Gies, of the Department of Biological Chemistry of Columbia University and Consulting Chemist to the New York Botanical Garden, for his oversight and aid throughout the course of the present work. We also extend thanks to Dr. Oswald Schreiner, of the Bureau of Soils, Washington, for numerous suggestions on various questions which have arisen pertaining to matters of soil fertility.

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NOTES ON NORTH AMERICAN HYPOCREALES—III. TWO NEW SPECIES WITH STUDIES OF THEIR LIFE HISTORIES

Fred J. Seaver

(With Plate 30, Containing 13 Figures)

So little is known of the life histories of the polymorphic species of the present order that any information which can be gained as to the complementary phases where the ascigerous stage is known is of much interest to mycologists. Not only is this true because of the fact that it gives us the knowledge of the life history of the individual species studied, but it furnishes at least a clue as to the direction in which to look for the complementary stages in other species where only the perfect or imperfect stages are known.

In my own studies of the Hypocreales, I have been much interested in the group of so-called imperfect fungi known as the Verticillieae and their perfect stages, several of which have been noted among nectriaceous plants. The Verticillieae are characterized by the verticillately branching conidiophores, the plants resembling in this respect *Penicillium*. The conidia are hyaline and borne either singly or in chains. The conidiophores often spring from a more or less well-developed stromatic base, giving the whole a floccose appearance of a whitish or pinkish color.

Among the Nectriaceae, the first species studied which was found to be associated with a *Verticillium* was *Creonectria ochroleuca* (Schw.) Seaver. This species has proved to be very common and a number of synonyms have been worked out. The examination of the types or cotypes of several of these synonyms has shown them to be associated with a *Verticillium*. Spegazzini seems to have been the first to call attention to the association of this *Nectria* with a *Verticillium* in his description of *Nectria vulgaris* Speg., which species is a synonym of the above. The

conidial stage of this species was also described as *Verticillium tuberculoides* Speg.

Creonectria seminicola Seaver, which, as stated in a previous paper, is closely related to the above, has also a *Verticillium* as its conidial stage.

Nectria Bainii Massee, which occurs an cacao pods in the West Indies, is also associated with a *Verticillium*. Our conclusion is here based on the examination of material collected in the West Indies, the identification of which has been confirmed at Kew and the specimens pronounced to be typical *Nectria Bainii* Massee. This species differs from the two preceding only in the slightly larger ascospores.

Recent studies of two undescribed species of nectriaceous plants, both of which have been found to be associated with Verticillieae, have furnished the data for the present paper.

The first of these, collected in Mexico during the winter of 1910 by Dr. W. A. Murrill, was reported to be a parasite on the stems of an undetermined palm. The original collection showed numerous pinkish stromata covering the stems of the host. A study of the microscopic characters showed the fungus to be one of the Verticillieae, and it was at once suspected that the fungus might be the conidial phase of a *Nectria* or one of the related genera. This suspicion was confirmed by the finding of other specimens of the host with both the conidia and perithecia. The conidia and perithecia were so intimately associated that it seemed likely that they represented two stages in the life history of the same fungus.

The ascospores are of an olivaceous or smoky-brown color, which character would place the fungus in the genus *Macbridella*. This genus was founded by the writer* to include two species of colored-spored, stromatic Nectrieae, both of which were collected in Central America. The occurrence of a new and third species of this genus in Mexico is of interest from the standpoint of distribution. It is also of interest to note that a fourth species which would properly belong to this genus has been reported from South America. These facts would indicate that the genus is composed largely of tropical species. The three North American

* Mycologia 1: 195. 1909.

species reported, while clearly belonging to the same genus, are specifically very different. The fact that this species occurs on the living stems of the host and is apparently connected with a group of fungi which is of some economic importance prompted an investigation of its life history.

CULTURE EXPERIMENTS

Drop cultures were made of the conidia and ascospores and both were found to be in a germinating condition. The ascospores produce usually two germ-tubes, which in twenty-four hours attain considerable length.

The host of the parasite was undetermined, and a small piece of the leaf was the only clue which we had as to its identity. In order to select a suitable host on which to cultivate the fungus, a visit was made to the palm house of the conservatories of the New York Botanical Garden with the hope or finding a plant similar to the fragment brought from Mexico. The leaves of plants of the genus *Chamaedorea* resemble the Mexican specimen, and a species of this genus was selected (*Chamaedorea Sartorii*) which was known to occur in Mexico. Unfortunately, the plants of this genus were not sufficiently abundant in the conservatories to permit of a living plant being used for inoculation, so a leaf was removed and the petiole used in our preliminary experiments.

The petiole was cut into pieces 2–3 inches in length. One of these was split and the inoculations made the full length of the split surface with the conidia from the original collection. The other speicmens were inoculated on the cut ends only. All were placed in test tubes with the lower ends immersed in distilled water. In about ten days, the split stems showed an abundant infection, the conidia being more or less effused and nearly covering the whole of the cut surface. The stromata later appeared on the opposite side of the stem, being at first scattered but later becoming more or less confluent. The color, as in the original specimen, was at first white, becoming pink with age. The plants were identical both in gross appearance and microscopic characters with the specimens from which the inoculations were made.

The specimens which were inoculated on the cut ends only took

the infection more slowly. The stems gradually became blackened, as was also the case in the preceding experiment, the stromata appearing as small pustules near the end of the stem, and gradually spreading down its side.

Other inoculations were made in a similar way on the petioles of the same and other species of *Chamaedorea,* and an abundant infection of the conidia followed in nearly every case. All of the culture material was allowed to remain moist, with the hope of producing perithecia. The latter part of April, about two months from the time of the planting of the conidia, perithecia were observed in two of the cultures, being produced in small clusters or occasionally more or less scattered. Perithecia were later seen in one of the cultures belonging to the second set of inoculations.

Both the perithecia and spores in the culture-grown specimens differed slightly from the original material, but these differences seemed to be due to the fact that the specimens were not properly matured. The perithecia were dull-red in color, while in the original material they were covered with olivaceous granules. The spores, also, were almost destitute of color. However, all of the morphological characters with the exception of the two mentioned above indicate that the species grown in culture is identical with the one from which the inoculations were made. The species may be described as follows:

Macbridella olivacea sp. nov.

Stromata erumpent, with a rather compact center, overtopped by numerous branching conidiophores, giving the whole a loose floccose appearance, at first white, becoming pink, about 1 μ in diameter, scattered or confluent; conidiophores verticillate-branched; conidia borne in chains, ellipsoid, 4–5 $\times$ 5–6 μ; perithecia occurring in cespitose clusters on or surrounding the stroma, dull-reddish, covered with olivaceous granules, giving the clusters a dark, greenish-black color; asci cylindric, 8-spored; spores 1-seriate, with the ends overlapping, fusoid or subelliptic, at first hyaline and surrounded by a transparent envelope, 1-septate, becoming olivaceous or smoky-brown and slightly constricted at the septum, externally marked with coarse striations, giving the surface a roughened appearance, with an oil-drop in each cell, 12–15 $\times$ 8 μ.

Type collected at Motzorongo, Mexico, on the stems of an undetermined wild palm, January 15, 1910, *W. A. Murrill 911.*

DISTRIBUTION: Known only from the type locality.

The second species described in this paper was first observed in the propagating houses of the New York Botanical Garden in

FIG. 1. Colonies of *Nectria zonata* Seaver spreading over green algae on flower pot.

1906, where it was found growing on the surface of soil covered with green algae. It was also later observed on the outside of pots containing living plants, always, so far as observed, spreading over green algae, *Pleurococcus,* etc. During the last two

years it has been under observation on such habitats, as it appeared continuously during this period on various pots in different parts of the propagating houses (*fig. 1*).

The most characteristic feature of the species is the appearance of a scant mycelial growth, which gradually radiates out from a common center and apparently originates from a single infection. As the mycelium proceeds outward, forming concentric rings or zones, it disappears in the center, leaving a bare space surrounded by the gradually enlarging rings of mycelium. The perithecia later appear scattered over the mycelial growth or in the central portion where the mycelium has disappeared. The mycelium is very scant and never, so far as observed, gives rise to a stroma, but at intervals under favorable conditions produces very delicate white tufts of conidiophores bearing conidia. While apparently belonging to the Verticillieae, both conidiophores and conidia are very different from those of the preceding species (*pl. 30*). The characters mentioned above would place this species in the genus *Nectria*. A diagnosis of the species follows.

Nectria zonata sp. nov.

Perithecia preceded by a scant mycelial growth which radiates from a common center, giving rise to concentric rings or zones, finally disappearing in the center, leaving a bare space surrounded by the gradually expanding rings of mycelium, with the conidiophores and conidia appearing as delicate white tufts; conidiophores verticillate-branched, with the conidia-bearing branches enlarged below, gradually tapering toward the apex; conidia borne in chains, fusiform, 10–12 × 5 μ, granular within and often appearing very minutely roughened; perithecia scattered, rarely two together, numerous, pale-orange or flesh-red, becoming slightly darker in dried specimens, under conditions of moisture covered, especially near the base, with a mycelial growth giving the plants a whitish appearance, or entirely naked; ostiolum slightly prominent, entire or rarely collapsing in dried specimens; asci clavate, 8-spored; spores partially 2-seriate or irregularly crowded, unequal-sided, broad-fusoid, 1-septate, slightly constricted at the septum, with the lower of the two cells narrower, filled with numerous oil-drops, hyaline, 17–18 × 8–9 μ.

Type collected in the propagating houses of the New York Botanical Garden on the outside of a pot containing living plants, May 20, 1910, *F. J. Seaver*.

DISTRIBUTION: Known only from the type locality.

EXPLANATION OF PLATE XXX

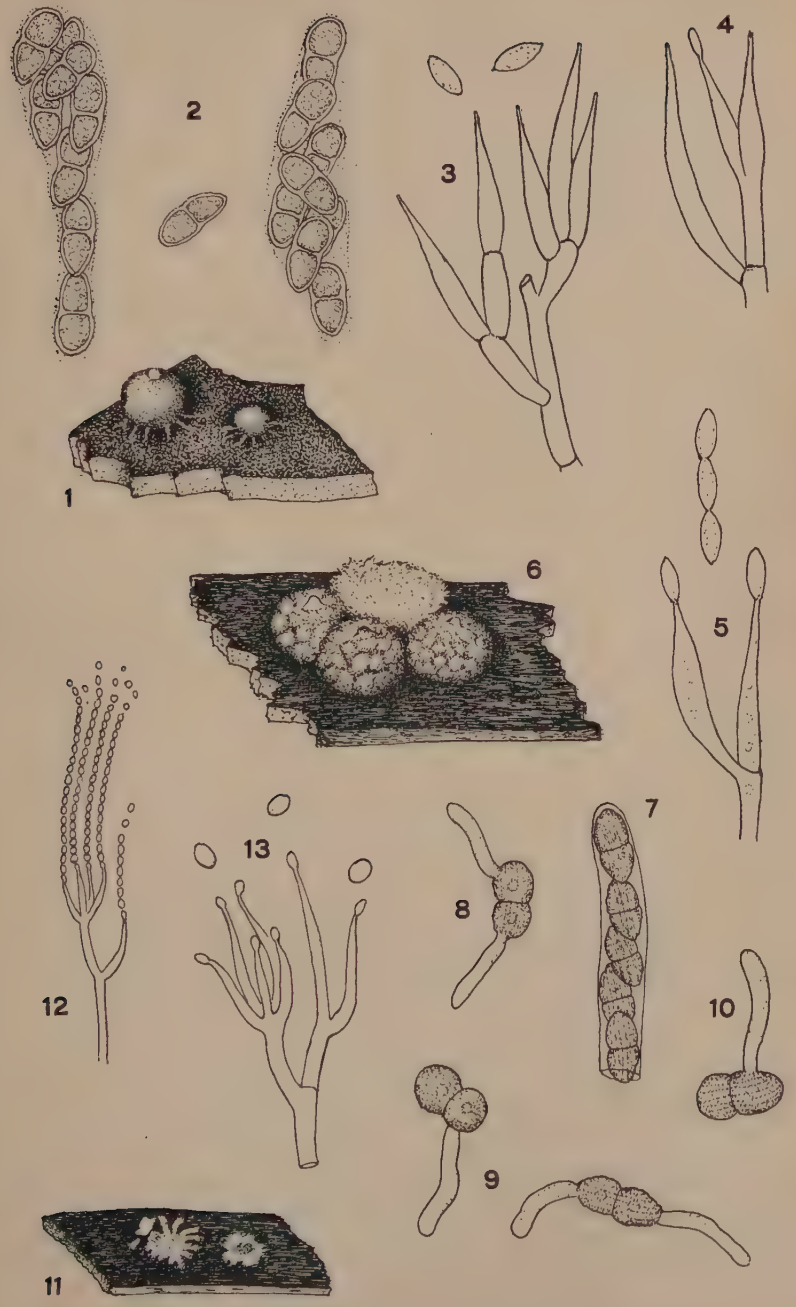
FIGS. 1–5. *Nectria zonata* Seaver

1. Perithecia.
2. Asci and spores.
3–5. Conidiophores and conidia.

FIGS. 6–13. *Macbridella olivacea* Seaver

6. Perithecia and stroma.
7. Portion of an ascus with spores.
8–10. Germinating ascospores after twenty hours in drop culture.
11. Young stromata.
12. Conidiophore and conidia (partially diagrammatic).
13. Conidiophore and conidia.

Figs. 2–5, 7–10, and 13 were drawn with the aid of the camera lucida.



1–5. NECTRIA ZONATA SEAVER
6–13. MACBRIDELLA OLIVACEA SEAVER

No 17.

[Reprinted from Mycologia, Vol. II., No. 4, July, 1910.]

The Genus Sphaerosoma.—Prof. W. A. Setchell, of the University of California, has recently published a paper on "The Genus Sphaerosoma" (Univ. of Calif. Pub. 4: 107–120, *pl. 15*). This paper is the outgrowth of the study of specimens of a new fungus collected in California which at first seemed to belong to the genus *Sphaerosoma*. The following is a brief synopsis of his conclusions:

The genus *Sphaerosoma* was founded by Klotzsch in 1839, *Sphaerosoma fuscescens,* an echinulate-hyaline-spored species being the type of the genus. A second species, *Sphaerosoma ostiolatum,* was described by Tulasne in 1851. This species is characterized by the brown-bluntly-tuberculate ascospores. In 1854, Zobel in the sixth volume of Corda's Icones Fungorum established a new genus, *Sphaerozone,* for *Sphaerosoma ostiolatum* Tul., which was described under the name *Sphaerozone Tulasnei* Zobel. In 1885, Hesse described a third species, *Sphaerosoma fragile.* In 1903, Hennings described, under the name *Ruhlandiella berolinensis,* a fungus which he considered close to *Sphaerosoma,* with reticulate-verrucose spores. In 1905, Seaver described a fourth species of *Sphaerosoma* under the name of *Sphaerosoma echinulatum.* In 1905, Rehm distributed (Ascom. *1601*) specimens from upper Silesia under the name of *Sphaerosoma echinulatum* Seaver. In 1908, Rouppert described a fourth species of *Sphaerosoma* under the name of *Sphaerosoma Janczewskianum,* and in 1909 published a monograph of the genus *Sphaerosoma* in which he recognized four species as belonging to the genus *Sphaerosoma,* one of which has reticulate spores, one verrucose spores, and two echinulate spores.

Setchell believes that the genus *Sphaerosoma* should be restricted to the echinulate-spored species, *Sphaerosoma fuscescens* Klotzsch (the type of the genus) and *Sphaerosoma echinulatum* Seaver, and that, since the European form of *Sphaerosoma echinulatum* differs from the American in having shorter and more slender spore-spines, it may come to be regarded as a

distinct species or may be only a geographical variety of the Iowa species.

The genus *Sphaerozone* Zobel should include the brown-verrucose-spored species, *Sphaerozone ostiolatum* (Tul.) Setchell. The new combination is published by Setchell, since, although the genus was based on this species, it was included by Zobel under the name *Sphaerozone Tulasnei.*

The genus *Ruhlandiella* was described by Hennings and based on a brown-reticulate-spored species, and, as stated above, was thought by Hennings to be closely related to *Sphaerosoma.* The Californian specimens are made the basis of a new species belonging to this genus, which is published by Setchell under the name *Ruhlandiella hesperia.*

From his study of the specimens of *Sphaerosoma* (in its restricted sense), Setchell believes that the plants of the genus are hemicleistocarpous and therefore belong more properly with the Pezizineae than with the Helvellineae, as has formerly been thought, and, since the plants have a weakly developed peridium, he suggests a possible relationship with the Pyronemaceae rather than with the Pezizaceae—F. J. SEAVER.

Collecting Fungi in Colorado

By FRED J. SEAVER

From the Journal of the New York Botanical Garden, No. 131, November 1910.

[Reprinted from JOURNAL OF THE NEW YORK BOTANICAL GARDEN, Nov., 1910.]

COLLECTING FUNGI IN COLORADO.

During the past summer, I spent a part of the month of August and September in Colorado, the object of the trip being to study and collect fungi in the Rocky Mountains in the vicinity of Denver. Leaving New York on the fifteenth of August, after a brief stop with friends in Iowa, we arrived in Denver on Saturday, August 20. The first few days were spent with Professor Elsworth Bethel, of the East Denver High School, who is one of the pioneer mycologists of Colorado, looking over his collections of fungi and selecting the more interesting for study, and in planning the course of our collecting campaigns. Much of the time I was accompanied by Mr. Bethel who, being familiar with every part of the state, aided me in selecting the best collecting grounds and very kindly contributed all of the material which he secured to the Garden collections, and in addition to these, numerous other specimens previously collected.

On the twenty-fourth of August we went by way of the Moffat Road, which is well known for its beautiful mountain scenery, to Tolland at an elevation of nearly 9,000 feet. Here we stopped several days and spent the time exploring the gulches and mountainsides in the vicinity, our trips extending up the canyon a distance of about eight miles, the highest point reached being about 10,000 feet. Above this the trees dwindled into

mere shrubs and vegetation became so scant that it was not thought worth while to extend our trip to higher altitudes. Mr. Bethel continually lamented the fact that conditions were so dry that our collections were not a fair sample of what Colorado had to offer in the way of fleshy fungi, but in spite of the dry weather, I had no reason to feel disappointed in the results of this trip, for in the few days spent here several hundred

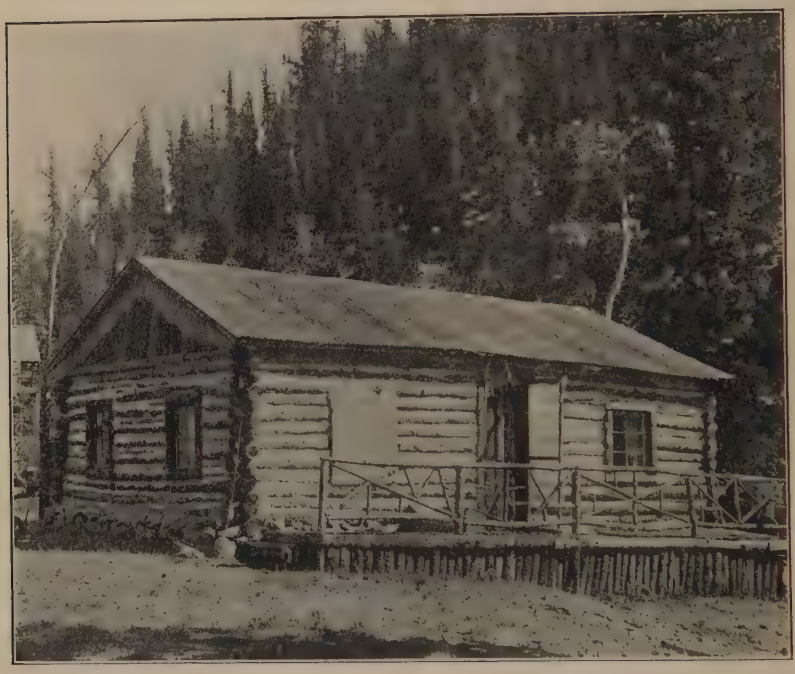


FIG. 36. Cabin, three miles from Grant, in which we lived during our collecting trip in the Geneva Creek Canyon.

specimens of fungi were collected. Professor Ramaley, of the State University of Colorado, who has his summer home at Tolland, very kindly gave us access to microscopes and accessories in his summer laboratory which is also located here. This furnished us the opportunity of making a microscopic study of some of the more interesting collections. Professor Ramaley also accompanied us on one of our longest trips.

After returning to Denver, one day was spent in the foothills

at Golden, at an elevation of 6,000 feet. From Golden we made a trip through one of the neighboring canyons and secured, among other specimens, a number of interesting leaf-parasites.

The principal collecting trip of our entire stay in Colorado was in the Geneva Creek Canyon, a branch of the Platt River Canyon. This is reached by taking the narrow-gauge line of the

FIG. 37. French Gulch one-half mile above the cabin. This is one of the gulches in which a number of interesting fungi were collected. The trees in the foreground are aspen (*Populus tremuloides*).

Colorado and Southern Railway, which ascends the canyon by keeping close to the river, a swift-flowing, clear stream which as it falls over the rocks adds much to the beauty of the natural scenery of the canyon. Leaving Denver in the morning, we arrived at Grant about noon, a distance of nearly one hundred miles from Denver. From this point we ascended the Geneva Creek Canyon by team to a distance of three miles. Here between two mountain streams is a small park in which a number of log cabins had been built to serve as temporary homes for summer resorters, and in one of these cabins we made our home for ten days. Our cabin was surrounded by numerous gulches

and mountain streams and the most of our collecting was confined to these, since the mountainsides were too dry to afford much outside of a few of the larger woody fungi. The small creeks which flowed through these gulches were bordered with mossy bogs which furnished many species of the smaller fleshy fungi.

FIG. 38. Geneva Park at an elevation of about 9,000 feet. The mountains in the background have an elevation of between 13,000 and 14,000 feet.

We extended our collecting trips up the canyon and on one occasion reached the crest of the mountain-range at a distance of from twelve to fifteen miles from our cabin and here attained an elevation of between 13,000 and 14,000 feet. Above timberline the conditions were not favorable for collecting fungi as would naturally be supposed; but I was surprised to find a few fleshy cup-fungi in mossy places even at some distance above snow line. At the crest of the mountain-range vegetation of all kinds was very scant.

One of the most interesting spots visited in the vicinity of our cabin was Geneva Park. The term park as here used applies to any level valley between mountain-ranges. Geneva Park, which was located about three miles above our cabin, is at an elevation of between 9,000 and 10,000 feet and covers an area five to seven miles long and one to two miles wide. The approach

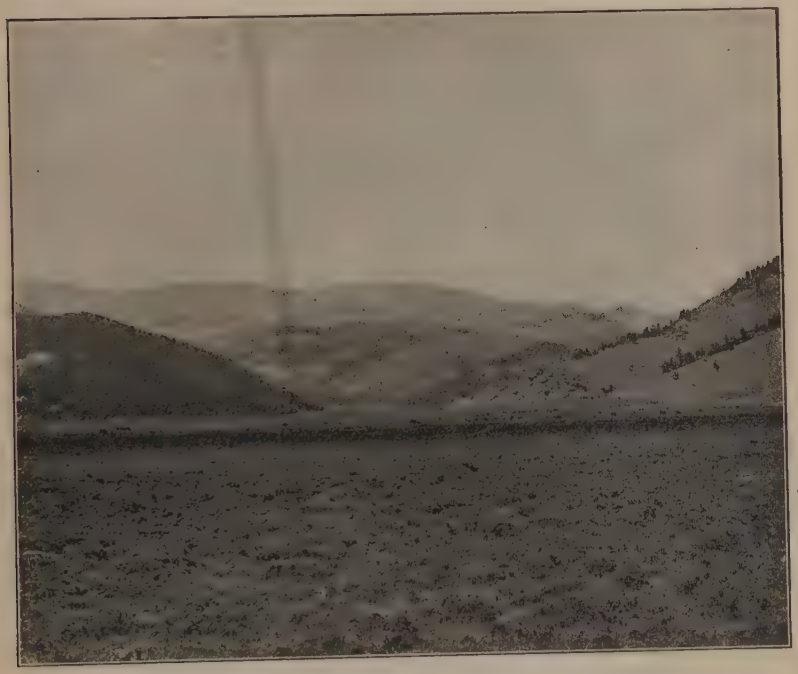


FIG. 39. View across Geneva Park showing swampy character of the soil. Cattle are grazing in the background.

leading to the park is very steep and rocky and probably represents the terminal moraine of a local glacier. The park would then result from the filling in of this natural reservoir with the wash from the mountainsides above. The entire region is surrounded by mountains except the comparatively narrow pass which furnishes an outlet for the creek which flows through it. The land itself is nearly level and the soil is swampy and furnishes a good substratum for fungi.

The country is not favorable for agricultural purposes on ac-

count of the short growing season resulting from the high altitude but the land is extensively used for grazing purposes. In former days it was doubtless a favorite hunting ground for the Indians, judging from the number of broken arrow-heads found in the vicinity. It is still frequented by deer, mountain-sheep and other forms of wild game. A comparatively short dam is all that is necessary to convert this beautiful park into a great natural reservoir and this is now being considered. The water which

FIG. 40. A mountainside near Geneva Park, from which the trees have been stripped and used for lumber.

could be stored in such a reservoir would serve to irrigate an immense area on the plains below where agricultural work can be carried on only by means of irrigation.

The standing timber, which consists mainly of coniferous trees (spruces, firs and pines), is not as large as would be expected in the canyons visited by us, but this is probably due to the fact that the larger and better trees have been cut down and used for lumber. Numerous sawmills have been operated in Geneva Creek Canyon and in places the ruins of the old mills and the mountainsides covered with rotting logs and charred stumps are all that remain to tell the story of wasted resources. In

places the stripped areas are covered with a second growth of small trees but in other places they remain bare and unprotected.

Among the deciduous trees and shrubs the aspen, mountain-alder, mountain-maple and willows are the most common. In places the aspen occurs in great numbers and attains considerable size and extends as high as timber-line. It, however, decreases in size as we ascend the canyon, and when we reach the timber-line it is no longer a tree but a low shrub and the leaves are so

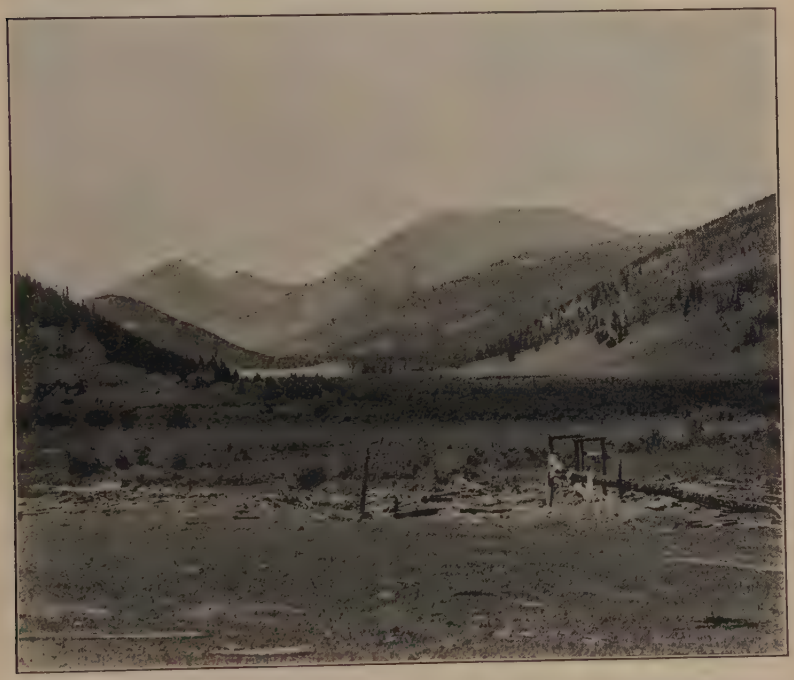


FIG. 41. Ruins of one of the many sawmills which have been operated in the canyon.

much reduced in size that we would scarcely recognize it as the same plant occurring at lower altitudes. The mountainsides were often covered with patches of aspen trees. Although our visit to the canyon was early in September, the temperature often dropped to the freezing point toward morning and the leaves of the aspen had already assumed the golden and scarlet colors characteristic of the autumn, and these bright colors in

contrast with the dark green of the coniferous trees did much to brighten and beautify the mountain scenery. Although the nights were cool, the air was clear and the temperature rose quickly in the morning so that in the middle of the day it was often uncomfortably warm, and on the whole the weather was ideal for collecting.

FIG. 42. A mountain cabin. Home of Mr. E. Sullivan, a homesteader and mine operator. The cabin is surrounded by aspen trees.

As would naturally follow from the small number of different kinds of deciduous trees and shrubs found in these mountain canyons, the number of wood-inhabiting fungi are relatively few. Several of the larger woody fungi which occur on coniferous trees were very common but here again the number of such species is restricted by the comparatively small number of different kinds of host plants. The smaller fleshy fungi which occur in moist soil, leaf-mould and mossy banks were quite abundant. The large flesh fungi were, judging from reports, not so abundant as usual on account of the dry season.

Probably the most interesting collections were among the cup-fungi. The number of such fungi which occur on damp soil, mossy banks and in boggy places were found to be especially abundant. Some of these were found to be parasitic on mosses in boggy places. Having collected and studied the cup-fungi in the middle West and East, I was impressed with the number of species common in the Rocky Mountains which were different from the common species collected in other places. This difference would depend partly on the climate at high altitudes, where most of the collections were made, many of the species probably being arctic or subarctic species. It would also depend in part on the different kinds of higher plants which give rise to the substrata for fungi, and this again is probably indirectly governed by the climate.

In addition to the fungi collected in the mountains, a number were collected on the plains about Denver. No actual count has been made, but as nearly as can be estimated from the various collections, about nine hundred specimens were brought home. While few of these specimens have yet been studied microscopically, I have every reason to believe that such study will furnish many points of interest to our knowledge of North American mycology, and possibly furnish some species new to science.

I wish here to acknowledge my indebtedness to Professor Bethel and also to my brother, Mr. Arthur G. Seaver, both of whom did all in their power to make our stay in Colorado both pleasant and profitable.

FRED J. SEAVER,
Director of the Laboratories.

No 19.

STUDIES IN COLORADO FUNGI—I. DISCOMYCETES

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. III, No. 2, March, 1911.

[Reprinted from MYCOLOGIA, Vol. III., No. 3, March, 1911.]

STUDIES IN COLORADO FUNGI—I. DISCOMYCETES

FRED J. SEAVER

The present report is based on a collection of fungi made by the writer and Professor Elsworth Bethel, during a part of last August and September, in the Rocky Mountains in the vicinity of Denver. The most of the collections were made about Tolland, on the Moffat Road, at an elevation of 9,000 to 10,000 feet, at Golden, in the foothills, at an elevation of 6,000 feet, and in Geneva Creek Canyon, at elevations of 8,000 to nearly 14,000 feet.

Of a collection of 900 specimens, about 250 were included in the discomycetes. A critical study of these has revealed a number of points of interest, and, for this reason, a list of the species determined is reported in the following paper, with comments on those which are of especial interest. A number of species collected I have been unable to determine, and these are held for more critical study. Specimens of the species reported here are deposited in the herbarium of the Garden.

GEOGLOSSACEAE

MITRULA GRACILIS Karst. Hedwigia **22**: 17. 1883

Dr. E. J. Durand in his recent monograph of the North American Geoglossaceae (Ann. Myc. **6**: 26. 1908) records this species from Labrador and Newfoundland; he also states that the species has been reported from Greenland. Our Colorado specimens agree well in spore characters and habitat with the description given by Dr. Durand. The plants occur attached to and apparently parasitic on some species of bog moss in one of the gulches of Geneva Creek Canyon, where they were collected in quantity. *Mitrula musicola* P. Henn., which has been reported from Alberta, is said to differ only in the larger size and more convolute hymenium. More than a hundred plants were collected in Colorado and on the same host the fungus was found to vary much in size; young plants were found with a stem not over 2 mm. long

and a pileus 1 mm. in diameter, while in older plants the stem was often 2 cm. long and the pileus as large as 4 mm. in diameter, the convolutions being more marked in old than in young plants. To me it would seem doubtful if these two species can be separated on these characters. A single specimen of *Mitrula musicola* was found in the Garden collection.

MITRULA IRREGULARIS (Peck) Durand, Ann. Myc. **6**: 398. 1908

Several specimens of this species were collected at Tolland, where the plants occur on bare ground or among moss in coniferous woods. The species has formerly been reported from Ontario and New Brunswick south to the District of Columbia.

HELVELLACEAE

HELVELLA ELASTICA Bull. Hist. Champ. Fr. 299. 1791

Two plants collected among moss in Geneva Creek Canyon.

RHIZINACEAE

PSILOPEZIA BABINGTONI Berk. Outl. Brit. Fungol. 373. 1860

On rotten wood in Geneva Creek Canyon.

PEZIZACEAE

BARLAEA CONSTELLATIO (Berk. & Br.) Sacc. Syll. Fung. **8**: 111. 1889

This species was found to be very common on damp soil, both at Tolland and in Geneva Creek Canyon. The plants are bright-red and the spores smooth, with one large oil-drop often surrounded by numerous smaller ones.

BARLAEA CREC'HQUERAULTII (Crouan) Sacc. Syll. Fung. **8**: 113. 1889

Ascobolus Crec'hqueraultii Crouan, Ann. Sci. Nat. IV. **10**: 194. 1858.

Peziza modesta Karst. Myc. Fenn. **1**: 64. 1871.

Crouania asperella Rehm, Hedwigia **24**: 226. 1885.

This species was collected in Pennsylvania in 1881 and distributed by Mr. Ellis in North American Fungi *841* under the name of *Peziza modesta* Karst., which species is undoubtedly a synonym of the above. The species has also been collected and reported by the writer from Iowa. Several collections of this species

were made in Colorado, at Tolland and in Geneva Creek Canyon. The plants collected in Colorado are as large as 5 mm. in diameter, a little larger than the Iowa specimens, but spore characters are identical. Cotype material of *Crouania asperella* Rehm has been examined and found to be the same. While the species has been commonly collected and distributed in European exsiccati, the only American specimens seen, with the exception of our own collections, were those distributed by Mr. Ellis in his exsiccati. *Peziza modesta* Karst. has also been reported from Minnesota by Miss D. Hone. For diagnostic characters and illustration, see Iowa Discomycetes.

DETONIA TRACHYCARPA (Curr.) Sacc. Syll. Fung. 8: 105. 1889

This specimen was mailed to me after returning from Colorado, having been collected by Professor E. Bethel at Lake Eldora, Sept. 17, 1910.

HUMARIA ORTHOTRICHA (Cooke & Ellis) Sacc. Syll. Fung. 8: 119. 1889

On the ground among moss, Geneva Creek Canyon.

HUMARIA RUBENS Boud. Bull. Soc. Myc. Fr. 12: 13. 1896

One collection in Geneva Creek Canyon.

LACHNEA MINIATA Funckel, Symb. Myc. app. 3: 32. 1875

The species is characterized by its reticulate spores. Two collections were made in Geneva Creek Canyon.

LACHNEA SETOSA (Nees) Gill. Discom. 75. 1879

One collection on wood at Golden.

LACHNEA UMBRORUM (Fries) Sacc. Syll. Fung. 8: 174. 1889

Abundant on soil at Tolland and in Geneva Creek Canyon. Similar in general appearance to *L. scutellata* but spores very rough, verrucose.

OTIDEA LEPORINA (Batsch) Fuckel, Symb. Myc. 229. 1869

One collection at Tolland.

PEZIZA CUPULARIS L. Sp. Pl. ed. 2. 1651. 1763

Common on the ground in coniferous woods at Tolland and in Geneva Creek Canyon.

PEZIZA BADIA Pers. Obs. Myc. 2: 78. 1799

On soil and rotten wood in Geneva Creek Canyon.

PEZIZA BRUNNEO-ATRA Desm. Ann. Sci. Nat. II. 6: 244. 1836

On soil in Geneva Creek Canyon.

SARCOSPHAERA ARENOSA (Fuckel) Lindau in E. & P. Nat. Pfl. 1[1]: 182. 1897

Two collections on sandy soil in Geneva Creek Canyon.

SPHAEROSPORA TRECHISPORA (Berk. & Br.) Sacc. Michelia 1: 594. 1879

On soil in Geneva Creek Canyon. The spores in this species are figured by Massee as being reticulate. I can find no reticulations although the spores are coarsely verrucose. Our specimens conform well with European specimens studied but the spores are slightly larger, reaching a maximum size of 26 μ in diameter, being much smaller, however, before reaching maturity. No other American specimens have been seen.

ASCOBOLACEAE

ASCOPHANUS CARNEUS (Pers.) Boud. Ann. Sci. Nat. V. 10: 250. 1869

Cultivated on horse dung from Tolland.

ASCOPHANUS ARGENTEUS (Curr.) Boud. Ann. Sci. Nat. V. 10: 245. 1869

Cultivated on cow dung from Geneva Creek Canyon.

ASCOPHANUS CINEREUS (Crouan) Boud. Ann. Sci. Nat. V. 10: 249. 1869

Cultivated on horse dung from Tolland.

ASCOPHANUS MICROSPORUS (Berk. & Br.) Phill. Brit. Discom. 307. 1887

Cultivated on rabbit dung from Geneva Creek Canyon.

ASCOBOLUS IMMERSUS Pers. Obs. Myc. 1: 35. 1796

Cultivated on cow dung from Geneva Creek Canyon and horse dung from Tolland.

ASCOBOLUS STERCORARIUS (Bull.) Schröter in E. & P. Nat. Pfl. 1: 198. 1897

Cultivated on cow dung from Geneva Creek Canyon and Tolland.

Ascobolus xylophilus sp. nov.

Plants gregarious, sessile, 1–2 mm. in diameter, dark-colored, blackish to the naked eye, reddish-brown with the lens; hymenium slightly concave or nearly plane; asci large, cylindric or clavate, 175–235 × 30–35 μ, operculate, 8-spored; spores 1-seriate or partially 2-seriate above, large, ellipsoid, with ends narrowed, purple, at first smooth, becoming slightly roughened, 35–38 × 13–15 μ.

On the weathered surface of some coniferous wood, Geneva Creek Canyon, September, 1910.

Two species of *Ascobolus* are reported by Saccardo on pine wood: *Ascobolus lignatilis* Albert. & Schw. and *Ascobolus denudatus* Fries. Our species is very different from either, both in gross and spore characters. This is, so far as we can find, the only North American species of the genus reported on wood, most of the species occurring on the dung of animals.

LASIOBOLUS EQUINUS (Müll.) Karst. Act. Soc. Faun. Fl. Fenn. 2: 122. 1885

On cow dung and horse dung from Tolland.

RYPAROBIUS CRUSTACEUS (Fuckel) Rehm, Ber. Naturh. Ver. Augsburg 26: 17. 1881

Cultivated on rabbit dung from Geneva Creek Canyon.

RYPAROBIUS PACHYASCUS Zukal; Rehm, Hedwigia 27: 167. 1888

Cultivated on horse dung from Tolland.

RYPAROBIUS SEXDECIMSPORUS (Crouan) Sacc. Syll. Fung. 8: 541. 1889

Cultivated on cow dung from Geneva Creek Canyon.

SACCOBOLUS KERVERNI (Crouan) Boud. Ann. Sci. Nat. V. 10: 229. 1869

On cow dung from Geneva Creek Canyon.

SACCOBOLUS NEGLECTUS Boud. Ann. Sci. Nat. V. 10: 231. 1869

Cultivated on horse dung from Geneva Creek Canyon.

HELOTIACEAE

CHLOROSPLENIUM AERUGINOSUM (Oeder) De Not. Comm. Critt. Ital. 1: 376. 1864

Only the stained wood of this species was collected by Professor Bethel, at Tolland, so that the identity of the species is uncertain.

HELOTIUM CITRINUM (Hedw.) Fries, Summa Veg. Scand. 355. 1849

Common on rotten wood, Tolland and Geneva Creek Canyon.

?HELOTIUM POPULINUM Fuckel, Symb. Myc. 316. 1869

The plants referred to this name are very minute and bright lemon-yellow, at least in fresh specimens, and occur in abundance on decaying leaves of *Populus tremuloides*. Fuckel's species is described as subfuscous and we are therefore in doubt as to the identity of our plants.

HELOTIUM SULPHURATUM (Schum.) Phill. Brit. Discom. 161. 1887

Common in Geneva Creek Canyon on dead spruce branches partially buried in the ground. Similar to *Helotium citrinum*.

DASYSCYPHA ARIDA (Phill.) Sacc. Syll. Fung. 8: 455. 1889

Peziza arida Phill. Grevillea 5: 117. 1877.

Lachnum Engelmanni Earle, Pl. Baker. 1: 25. 1901.

Dasyscypha fuscosanguinea Rehm, Ascom. 112; Ber. Naturf. Ver. Augsburg 26: 30. 1881.

This species was originally described from material collected in Blue Canyon, Sierra Nevada Mountains, California, by Harkness and Moor. The type has not been seen but a specimen in the herbarium of the New York Botanical Garden collected by Dr. Harkness in Blue Canyon, California, has been examined and our Colorado specimens conform well with this. Dr. Rehm (l. c.) states that this species is a variety of *Dasyscypha fuscosanguinea* Rehm. So far as we can see they are identical but inasmuch as Dr. Rehm's specimens were distributed without a description we cannot do otherwise than accept the name published by Phillips. Numerous specimens were collected at Tolland and in the Geneva Creek Canyon and at first referred to *Lachnum Engelmanni* Earle, which species was later found to be identical with that of Phillips.

The species appears to be common and widely distributed, specimens having been examined from California, Colorado, Montana, Oregon, Washington, and Newfoundland, occurring on dead branches of pines and spruces.

Dasyscypha chlorella nom. nov.

Lachnum viridulum Massee & Morgan; Morgan, Jour. Myc. 8: 187. 1902. ?Not *Dasyscypha viridula* (Schrad.) Sacc. Syll. Fung. 8: 437. 1889.

The type of *L. viridulum* has not been seen, but our specimens conform well with a colored drawing made from the type by Massee, as well as with the original description. A specimen collected at Tolland seems to conform with the one collected in Geneva Creek Canyon except that the plants have faded to nearly white.

LACHNELLA CORTICALIS (Pers.) Fries, Summa Veg. Scand. 365. 1849

Common on bark, more rarely on decorticated wood at Golden and in the Geneva Creek Canyon. The species is very variable, the spores being clavate or fusiform, often as long as 26 μ and with 1–3 delicate septa. *Lachnella canescens* Cook; Phill. Brit. Discom. 259 appears to be identical.

LACHNELLA FLAMMEA (Albert. & Schw.) Fries, Summa Veg. Scand. 365. 1849

Peziza flammea Albert. & Schw. Consp. Fung. 319. 1805.
Dasyscypha allantospora Earle, Pl. Baker. 2: 5. 1901.
Lachnella rhoina Earle, Pl. Baker. 2: 6. 1901.

Very common on dead twigs of various kinds at Tolland and in the Geneva Creek Canyon. The types of *Dasyscypha allantospora* and *Lachnella rhoina* have been examined and found to be rather faded specimens of the above. The spore measurements of the latter species given by Professor Earle are too small.

LACHNELLA RESINARIUS (Cooke & Phill.) Phill. Brit. Discom. 242. 1887

Specimens collected at Tolland conform fairly well with the original description of this species. The plants occur on the bark of some conifer and somewhat resemble *Lachnellula chrys-*

ophthalma, but are smaller, a little less hairy, and the spores are very different, being ellipsoid or allantoid, while in the latter species they are globose.

LACHNELLULA CHRYSOPHTHALMA (Pers.) Karst. Medd. Soc. Faun. Fl. Fenn. **11**: 138. 1884

This is one of the most common species of cup-fungi on conifers in the canyons of the mountains, both at Tolland and at Geneva Creek, and being rather large and bright-colored, is easily detected. Our plants compare very favorably with European exsiccati and although common in the Rocky Mountains, no American specimens could be found in our collections at the New York Botanical Garden.

MOLLISIACEAE

MOLLISIA CINEREA (Batsch) Karst. Myc. Fenn. **1**: 189. 1871

One collection on old wood near Tolland.

ORBILIA VINOSA (Albert. & Schw.) Karst. Myc. Fenn. **1**: 101. 1871

On old wood in Geneva Creek Canyon.

ORBILIA FLEXUOSA Grossl. Grevillea **22**: 44. 1893

On old wood in Geneva Creek Canyon.

PSEUDOPEZIZA MEDICAGINIS (Lib.) Sacc. Malpighia **1**: 455. 1886

Abundant on leaves of alfalfa at Golden.

PATELLARIACEAE

PATELLARIA ATRATA (Hedw.) Fries, Syst. Orb. Veg. 113. 1825

On old wood in Geneva Creek Canyon.

CENANGIACEAE

CENANGIUM POPULNEUM (Pers.) Rehm in Rabenh. Krypt. Fl. **1**: 220. 1896

Common on *Populus tremuloides* in Geneva Creek Canyon.

Godronia Betheli sp. nov.

Ascomata erumpent through the outer bark of the host, single or occurring in clusters, often so numerous as to form congested masses many cm. in diameter and almost entirely surrounding the branches on which they grow; individual ascomata at first nearly

globose, opening at the top so as to leave an irregular margin, at maturity about 1 mm. broad and the same in height, brownish and furfuraceous externally, hymenium freely exposed at maturity, whitish or bluish-white; asci clavate, 130 × 7–8 μ, 8-spored; spores in a fascicle in the ascus, subfiliform, tapering toward either end, sharp-pointed, 65–85 μ long and 3–4 μ thick at the broadest point, becoming 7-septate at maturity and often slightly constricted at the septa, hyaline; paraphyses abundant, filiform.

On the branches of some species of willow, Tolland, August, 1910.

STICTIDACEAE

CRYPTODISCUS ATRO-CYANEUS (Fries) Sacc. Syll. Fung. 8: 670. 1889

Very common on old wood of *Populus tremuloides*, Geneva Creek Canyon, Golden and Tolland.

Ocellaria ocellata (Pers.)

Peziza ocellata Pers. Syn. Fung. 667. 1801.
Ocellaria aurea Tul. Fung. Carp. 3: 129. 1865.
Dermatea inclusa Peck, Ann. Rep. N. Y. State Mus. 30: 62. 1878.
Dermatea macrospora Clements, Bull. Torrey Club 30: 87. 1903.

The plants are erumpent but do not rise much above the surface of the bark. Very common on willow about Tolland. Fungi Columbiani *1918*, issued as *Dermatea inclusa* Peck, is identical with our Colorado specimens and so far as we can judge from the description Dr. Peck's species is identical with the above.

PROPOLIS FAGINEA (Schrad.) Karst. Myc. Fenn. 1: 244. 1871

Propolis versicolor Fries, Summa Veg. Scand. 372. 1849.

On old wood, Tolland.

STICTIS RADIATA (L.) Pers. Obs. Myc. 2: 73. 1799

On old wood, Geneva Creek Canyon and Tolland.

HYPODERMATACEAE

HYPODERMA LINEARE (Peck) Peck; Thüm. Myc. Univ. 1073. 1878

Rhytisma lineare Peck, Ann. Rep. N. Y. State Mus. 25: 100. 1873

Abundant on leaves of *Pinus* sp. in the vicinity of Tolland.

This species is characterized by its peculiar spores which appear like two spores united by a very narrow neck.

LOPHODERMIUM ARUNDINACEUM (Schrad.) Chev. Fl. Par. 1: 435. 1826

One specimen collected at Tolland on the stems of some grass.

HYSTERIACEAE

HYSTERIUM COMPRESSUM Ellis & Ev. Jour. Myc. 8: 69. 1902

On old wood in Geneva Creek Canyon.

HYSTEROGRAPHIUM MORI (Schw.) Rehm, Ber. Nat. Ver. Augsburg 26: 90. 1881

Collected on old wood at Berkeley by Professor E. Bethel.

HYSTEROGRAPHIUM VULVATUM (Schw.) Rehm, Ascom. *315*.

On old wood at Golden and Tolland.

NEW YORK BOTANICAL GARDEN.

NO 20.

[Reprinted from MYCOLOGIA, Vol. III., No. 3, May, 1911.]

The Genus Fimetaria.—With reference to the substitution of *Fimetaria* for the generic name of those fungi commonly included in the genus *Sordaria,* the following criticism appears in Ann. Myc. 9: 192: "Aus welchem Grunde der allbekannte Gattungsname *Sordaria* durch den neuen Namen *Fimetaria* ersetzt wirt ist nicht ersichtlich. Jedenfalls ist diese Umnennung nicht zu billigen, wie auch in der im Jahre 1901 erschienenen monographischen Bearbeitung der nordamerikanischen Sordariaceen seitens Griffiths der Gattungsname *Sordaria* beibehalten worden ist."

The new generic name was published in *North American Flora* 3: 65. Since no opportunity is given in that work for extended notes and in view of the above criticism, it is thought well to give our reasons for this substitution of names.

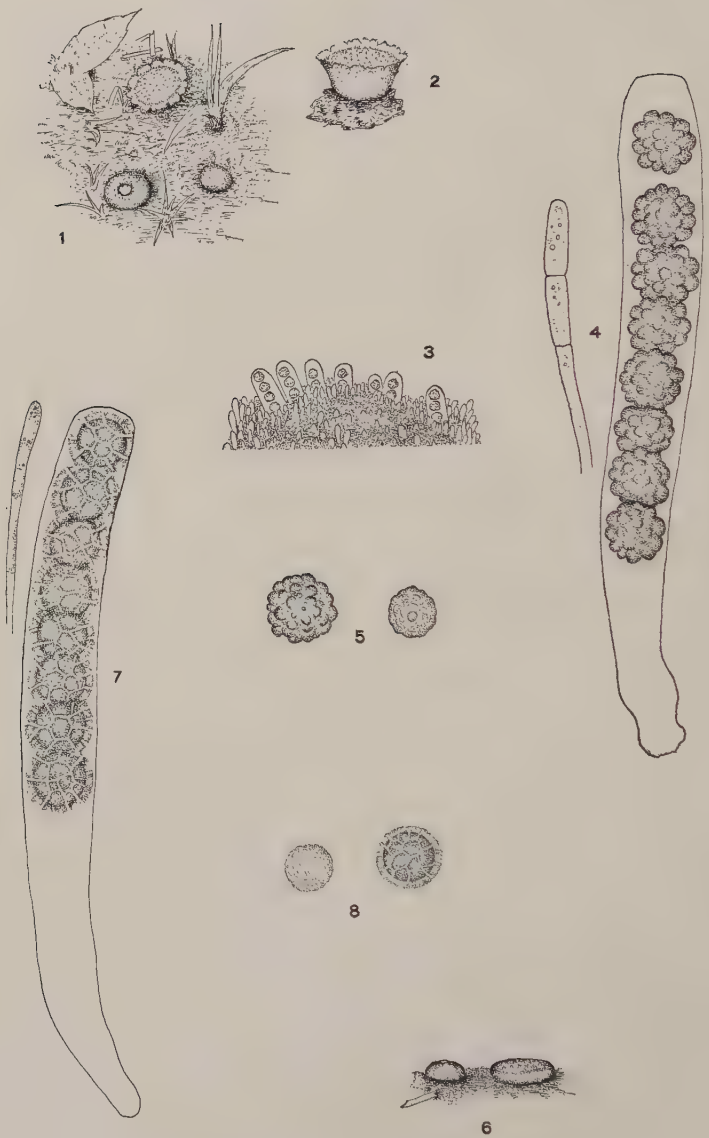
In the American Code of Botanical Nomenclature, sec. IV, canon 15 (c), we find the following rule relative to the fixing of the type of a genus. "The application to a genus of a former specific name of one of the included species designates the type." As an illustration of the application of the above rule we read the following: "*Sordaria* Ces. & DeN. Comm. Soc. Critt. Ital. 1: 225 (1863), is typified by *Sphaeria Sordaria* Fr., one of its twelve species." *Sphaeria Sordaria* is, according to recent authorities, a *Rosellinia,* in the sense that *Rosellinia* is now used. The name *Sordaria* would then become a synonym of *Rosellinia* as now used, and the group of species to which the name *Sordaria* is commonly applied would be left without a name and since there is no other name in literature which could be taken up for the genus, the only alternative is the substitution of a new name. In brief, then, this substitution of *Fimetaria* as the generic name of those species commonly known by the old name *Sordaria* was made in order to make the work of *North American Flora* conform to the requirements of the rules of the American Code of Botanical Nomenclature.—*F. J. Seaver.*

AUG 21

THE GENUS LAMPROSPORA, WITH DESCRIPTIONS OF TWO NEW SPECIES

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. IV, No. 2, March, 1912



1–5. LAMPROSPORA TUBERCULATA SEAVER
6–8. LAMPROSPORA AREOLATA SEAVER

[Reprinted from MYCOLOGIA, Vol. IV., No. 2, March, 1912.]

THE GENUS LAMPROSPORA, WITH DESCRIPTIONS OF TWO NEW SPECIES

FRED J. SEAVER

(WITH PLATE 57, CONTAINING 8 FIGURES)

The genus *Lamprospora* was founded by De-Notaris in 1864, with *Ascobolus miniatus* Crouan, one of the globose-spored operculate cup-fungi as its monotype.

In 1869 Fuckel published the genus *Crouania* with *Crouania miniata* (Crouan) Fuckel as the type of the genus. This name is untenable, having been previously used for a genus of algae,[1] and in addition is antedated by the above name.

In 1889 the name *Barlaea* was proposed by Saccardo with *Crouania* Fuckel as a synonym. This name is also untenable, having been previously used for a genus of flowering plants.[2] Saccardo discovering this fact, later published the genus *Barlaeina* with *Barlaea* Sacc. as a synonym.

Lamprospora therefore appears to be the proper name to be used for the smaller plants of the globose-spored type of operculate discomycetes, except those which are commonly placed with the Ascobolaceae, through its priority of date and with the additional fact that two of the more recent generic names proposed are untenable for reasons mentioned above.

For several years past the writer has been interested in the col-

[1] Agardh, J. G., Alg. Mar. Med. 83. 1842.

[2] Reichenbach, H. G., Linnaea 41: 54. 1877.

[Mycologia for January, 1912 (4: 1–44), was issued January 6, 1912].

lection and study of these minute but interesting plants and the recent collection of two apparently undescribed species has prompted the writing of the present paper. For the following reasons both the collection and study of the plants of this genus is difficult and unsatisfactory.

1. The plants are often so small that they are easily overlooked and for this reason seldom collected.

2. The descriptions of the known species are so fragmentary that in many cases they do not render the plants recognizable.

3. The type specimens preserved in the ordinary way are of little value since the plants, at best small, become much smaller on drying and are often lost with the crumbling earth on which they usually grow.

These difficulties are partly compensated by the fact that while the plants are very small the spores, as a rule, are unusually large. In addition to their large size they are often sculptured, the nature of the sculpturing furnishing valuable diagnostic characters. The type species of the genus has the spores covered with delicate, shallow reticulations. Other species have the spores marked with deep reticulations, sharp spines, minutely verrucose or coarsely tuberculate. In a number of species the spores are smooth and we must in such cases rely upon other diagnostic characters. In addition to the preservation of plants on the substratum for the study of gross characters in the ordinary way microscopic slides should be preserved, especially in those forms in which the spores furnish diagnostic characters. With careful drawings and descriptions from fresh material and specimens preserved in the above manner the species of the genus should be made recognizable.

The plants of this genus show rather close relationship with some of the Ascobolaceae both in the character of the spores and asci as well as in the protrusion of the asci above the surface of the hymenium, the latter character being the one on which the Ascobolaceae are distinguished from the Pezizaceae. To the writer it seems very doubtful if there is any morphological character by which these two families can be separated. The most natural classification of the true cup-fungi (Pezizales) to my

mind, is that proposed by Boudier,[3] *i. e.*, to separate them into the operculate and non-operculate forms. The former group would include those in which the asci open by an operculum or lid and the latter those in which the asci open by a pore. As pointed out by Boudier these characters are accompanied by numerous others which strongly suggest a natural division. This classification would throw together the Ascobolaceae and Pezizaceae unless some morphological character can be discovered on which they can be distinguished other than that which is commonly used. The occurrence of many of the Ascobolaceae on the dung of animals is a convenient character but there are so many exceptions that this can hardly be relied upon as a characteristic of the family. If the Ascobolaceae are kept distinct on the character usually employed, the protrusion of the asci, at least some of the species of the genus *Lamprospora* should be placed among the Ascobolaceae. Whether the entire genus should be transferred I am uncertain. To my mind the most natural thing would be to ignore the family distinctions of the Ascobolaceae and Pezizaceae and key out the genera regardless of this family distinction.

LAMPROSPORA De-Not. Comm. Critt. Ital. 1: 388. 1864

Crouania Fuckel, Symb. Myc. 320. 1869.

Barlaea Sacc. Syll. Fung. 8: 111. 1889.

Barlaeina Sacc. Syll. Fung. 14: 30. 1899.

Plants small, scarcely exceeding 5 mm. in diameter, concave, plane or slightly convex, usually bright-colored or more rarely pallid, fleshy, hymenium often roughened by the protruding asci; asci 8-spored, operculate; spores comparatively large, globose, at first smooth, at maturity often sculptured, verrucose, echinulate, reticulate or tuberculate or permanently smooth, hyaline; paraphyses numerous and usually clavate.

Type species, *Ascobolus miniatus* Crouan.

Lamprospora tuberculata sp. nov.

Plants small, 0.5–1 mm. in diameter, hymenium gradually expanding, at maturity plane or slightly convex, bordered by a

[3] Boudier, E., On the importance that should be attached to the dehiscence of asci in the classification of the discomycetes. Grevillea 8: 45–48. 1879.

delicate fringe, pale orange; hymenium roughened by the protruding asci; asci cylindric, operculate, 15–18μ in diameter; spores globose, at first smooth with a large oil-drop, gradually becoming roughened, at maturity coarsely tuberculate, about 16μ in diameter, hyaline; paraphyses clavate (*pl. 57, f. 1–5*).

On damp soil among moss in open places; type collected near Yonkers, New York. The same species has been collected by the writer in New Jersey and by Mr. B. O. Dodge in Virginia.

Lamprospora areolata sp. nov.

Plants small, 0.5–1 mm. in diameter, at first globose opening rather irregularly, at maturity with the hymenium plane or slightly convex, more or less roughened by the ends of the asci, bright red; asci cylindric, 15–18μ in diameter, 8-spored; spores globose, at first smooth, with a large oil-drop, becoming rough at maturity deeply areolate, about 16μ in diameter; paraphyses clavate (*pl. 57, f. 6–8*).

On soil among moss in a beaten path in woods near Yonkers, New York.

Both the plants and the spores are similar to *Humaria calospora* Quél. as figured by Boudier in Ic. Myc. *pl. 400,* except that the spores are perfectly globose instead of ellipsoid.

·/1 6 22.

CONTRIBUTIONS FROM THE NEWYORK BOTANICAL GARDEN — No. 149

STUDIES IN PYROPHILOUS FUNGI—III. THE VIABILITY OF THE SPORES OF PYRONEMA

By FRED J. SEAVER

NEW YORK
1912

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[From the Bulletin of the Torrey Botanical Club, 39: 63-67, *pl. 4.* 9 Mr 1912.]

Studies in pyrophilous fungi—III.* The vitality of the spores of Pyronema

Fred J. Seaver

(with plate 4)

In the first paper of the present series, in attempting to impress upon botanists the value of *Pyronema* as a plant to be used in regular class study, it was stated that no data were at hand as to the length of time during which the spores of this fungus would keep their viability. As a knowledge of this point is of vital importance in determining whether the teacher is able to tide over this plant in the laboratory from year to year, it is deemed worthy of special study and mention at this time.

As has been previously stated, when once this fungus has been cultivated it is comparatively easy to "get a catch" from the air by simply exposing properly heated soil and keeping it moist for a few days. Especially is this true in greenhouses. To my knowledge, since this fungus has been under observation here, steamed or heated soil used for planting in the propagating houses of the New York Botanical Garden has never failed to develop the fungus. Some time ago the spores of the fungus were sent to Purdue University for experimental purposes, and recently in a conversation with Dr. F. D. Kern he informed me that this fungus also now made its appearance in their greenhouse whenever heated soil was exposed. While the fungus may usually be obtained in this way when once it is started, this method is uncertain and the occurrence of the plant is likely to be delayed when it is most needed. It is therefore better to develop and rely upon some more certain methods of securing and preserving it.

During the present winter the fungus was desired for study in classes at Columbia University, and several pots of heated soil were exposed to the air, as formerly, in the laboratories of the

* Studies in pyrophilous fungi—II. Changes brought about by the heating of soils and their relation to the growth of *Pyronema* and other fungi, was published in Mycologia 2: 109–124. *pl. 24–26.* 1910.

New York Botanical Garden. As it had been some time since the fungus had been under cultivation at the Garden, the spores were apparently not very numerous in the air, for after several days the plant failed to appear. Search was then made for some recently collected spores for inoculation. No attempt had been made to keep the spores for this purpose and the youngest specimens available in the herbarium of the Garden had been collected nearly three years before. The soil was inoculated with these aged spores, and within a few days a good growth of *Pyronema* was produced, the infection apparently proceeding from the point of inoculation. As this experiment did not prove with certainty that the old spores germinated, it was decided to test them out in hanging drop culture.

A complete history of the specimen used in the above experiment is as follows. In the spring of 1909, a pile of leaves and brush was burned, and this opportunity was taken to test the growth of *Pyronema* under natural conditions, as the fungus was at that time under cultivation in the laboratory. Spores were taken from the plants grown in the laboratory and with these the burned place was inoculated. In a reasonably short time our burned place showed a good growth of the fungus. One good specimen was collected and placed in the herbarium of the Garden in an ordinary paper packet. In January 1912 the spores from this specimen were used for the experiment described above, and while many of the spores failed to germinate, there was enough growth in a hanging drop culture to form a web of mycelium over the cover glass on which the spores were planted.

The spores of *Pyronema* are rather thin-walled and are not the kind of spores, so far as general appearance is concerned, that would be expected to keep their viability for a long period of time. Also, it would naturally be thought that spores which are adapted to withstand long periods of unfavorable conditions as resting spores would not germinate readily when fresh. The spores of this fungus are an exception in both of these particulars, for the fresh spores germinate very readily in hanging drop culture and very old spores germinate with equal facility; also, the walls of the spores do not appear to be thicker than the walls of the young mycelium and show no protective structures.

The spores germinate by putting out a germ tube from each end, one end, however, growing much faster than the other. The young mycelium is very coarse, the diameters of the main branches being fairly constant. The whole mycelium is filled with vacuoles, giving it a characteristic appearance. The spore before germinating swells much, becoming large and very granular. The germ tube as it issues from the spore is slightly smaller in diameter than the spore but often swells to about the same diameter. The contents of the spore after germination are similar in appearance to the contents of the young mycelium, and there appears to be no difference between the wall of the old spore and that of the young mycelium, the spore forming one segment in the growing mycelium, usually of a little larger diameter and shorter but often so nearly like the other segments of the mycelium that it is difficult to determine the position of the old spore. In some cases the spore seems to swell up and begin to grow by simply cutting off new segments at either end.

The spores of *Pyronema*, as shown in the present experiment, will keep their viability for nearly three years; as to how much longer they will remain good we cannot at present say. Griffiths* in his work on Fimetariaceae (Sordariaceae) found one species in which the spores kept their viability for more than three and one-half years.

The demonstration of the long viability of the spores of *Pyronema* is one more argument in favor of the introduction of this fungus into college and university courses in botany which deal with a general knowledge of the subject. The cultivation of the fungus requires no complicated technique, and the rapidity with which the plant grows would enable the student to study all of the stages from the germinating spore to the production of sex organs and mature ascocarps within a period of about ten days. Also, the asci of *Pyronema* when mounted in water illustrate very nicely the common method of spore dissemination among the ascomycetes.

Claussen† in his recent paper on the development of *Pyronema*

* Griffiths, D. The North American Sordariaceae. Mem. Torrey Club 11: 1–134. *pl. 1–19.* 30 My 1901.

† Claussen, P. Zur Entwicklungsgeschichte der Ascomyceten, *Pyronema confluens.* Zeit. Bot. 4: 1–80. *pl. 1–6.* 1902.

states: "Es wirt angegeben dass *Pyronema* auf Brandstellen häufig vorkomme. Häufig kann aber wohl der Pilz nicht sein, da ich ihn bisher nur ein einziges Mal—bei Eberswalde—im Freien fand. So oft ich sonst sowohl bei Freiburg wie bei Berlin solche Stellen absuchte, hatte ich keinen Erfolg."

While nothing can be said here as to the occurrence of the fungus in Europe, the fact remains that it is fairly common in America so far as our knowledge goes. Of course its occurrence in nature depends upon the presence of recently burned areas accompanied by a reasonable amount of precipitation. Given these conditions, and the fungus is common. It has been collected by the writer in Indiana, Iowa, New York, and North Dakota and has been frequently reported by collectors from other states.

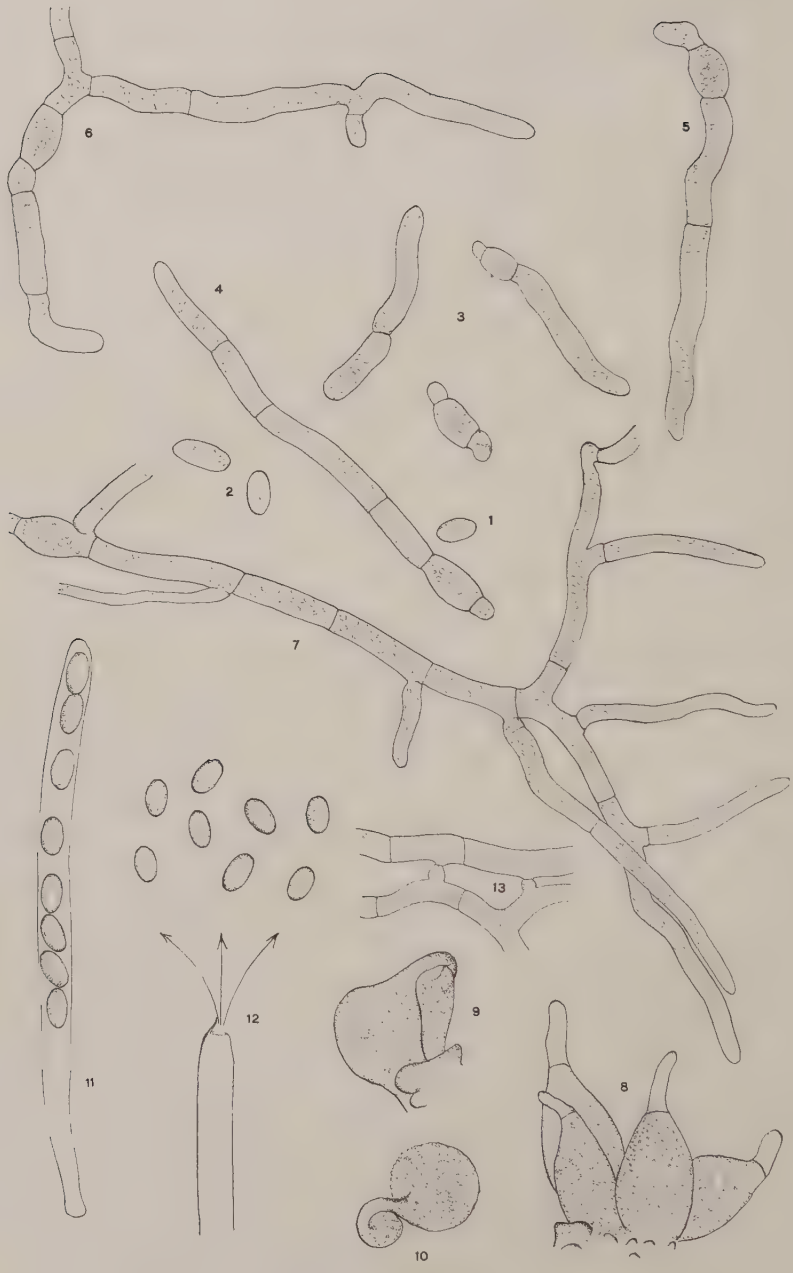
If it should happen that the fungus is not common in a given locality, or as is more likely to be the case, has never been recognized, it has been shown in previous papers that the fungus is easily cultivated in the laboratory; and now having proved the long viability of the spores which enables the plant to be carried over for an indefinite length of time in the laboratory, there is no longer any reason for considering *Pyronema* an uncommon fungus. If the fungus is worth knowing from a morphological point of view it is also worth seeing.

DIRECTIONS FOR CULTIVATION AND PRESERVATION OF THE SPORES

Heat good rich, unfertilized, garden soil by placing it in pots or other receptacle. The heating can be accomplished by steam or dry heat in an autoclave or sterilizing oven. If dry heat is used run the temperature up to 150°–170° C. If neither autoclave nor sterilizing oven is available, bake in an ordinary oven for an hour or more at ordinary baking temperature. Cool and water with tap water. Plant the spores and place the pot under a bell jar. Growth of mycelium should be abundant in two or three days at room temperature; sex organs should appear in about a week and mature ascocarps a few days later.

When through with the study of plants, scrape off the old ascocarps together with a little dirt, place them in an envelope and keep dry until they are desired for study the next year, then prepare substratum and plant as before.

NEW YORK BOTANICAL GARDEN.



SEAVER, ON PYRONEMA

Explanation of plate 4

Pyronema omphalodes

1. Normal ungerminated spore.
2. Spores slightly swollen and apparently about to germinate.
3–7. Stages in the germination of spores on the third morning after planting.
8. Young ascogonia.
9–10. Ascogonia and antheridia, side and end view.
11. Mature ascus.
12. Ascus showing dissemination of spores.
13. Anastomosing mycelium.

All figures are drawn with the camera lucida; 1–7 and 13 show stages in the developing spores collected in the spring of 1909 and germinated January 1912, as they appeared on the third morning after planting.

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BIOCHEMICAL STUDIES ON SOILS SUBJECTED TO DRY HEAT

FRED J. SEAVER AND ERNEST D. CLARK

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BIOCHEMICAL STUDIES ON SOILS SUBJECTED TO DRY HEAT

FRED J. SEAVER AND ERNEST D. CLARK

(Laboratories of the New York Botanical Garden and of the Department of Biological Chemistry of Columbia University)

(With plate 7)

INTRODUCTION

In our earlier communications on the relation of heated soils to the growth of plants we concerned ourselves only with the effects on the fungi, especially *Pyronema*. In our first paper[1] we reported that this fungus fails to develop on unheated soils, but can be made to thrive and develop abundant fruit on soils that have been heated. At that time it was suggested that heat seemed to produce chemical changes in the soil as well as to eliminate the competition of bacteria, other fungi, etc., with *Pyronema*. In the second paper[2] our experiments indicated that the inhibiting factor in unheated soils did not seem to be a toxin destroyed by heat, as had been claimed by Kasaroff. On the contrary, the better growth on soils which had been heated in an oven appeared to be parallel to the amount of soluble matter and to the depth of color of the water extract, both of which in turn were dependent upon the temperature to which the soils had been exposed. Temperatures of 125° to 180° C. gave very dark-colored extracts, with the odor of burnt sugar, due to the large amount of peculiar organic substances held in solution. Extracts obtained from such heated soils proved to be ideal culture media for *Pyronema* and others of the lower fungi, judging from the difficulty we had in keeping the extracts sterile. The addition of heated soil extracts to unheated soil did not render it favorable for *Pyronema* growth; and furthermore, analysis showed that

[1] Seaver: Studies on pyrophilous fungi. I. The occurrence and cultivation of *Pyronema*. Mycologia, 1: 131-139. 1909.

[2] Seaver and Clark: Studies on pyrophilous fungi. II. Changes brought about by the heating of soils and their relation to the growth of *Pyronema* and other fungi. Mycologia, 2: 109-124. 1910.

the unheated soil removed nearly all the soluble matter in the deeply colored extracts allowed to percolate through it. This interesting phenomenon has been noticed by us repeatedly, but whether it is due to chemical, physical or physico-chemical action we can not say. Since we first became interested in the effects produced by heating soil several other investigators have published the results of their studies on this subject. We have confined ourselves to the use of dry heat, while nearly all the others used steam heat.

DISCUSSION OF THE WORK OF OTHER INVESTIGATORS

At the Rothamsted Experiment Station in England, Russell and Hutchinson[3] studied the effects on soils produced by heating to a low temperature (98° C.) and by treatment with volatile antiseptics. Under these conditions they found that the fertility of the soil was enhanced and that this was due to an increase in the nitrogenous food thus made available. This effect seemed to be the result of the quickened activities of certain nitrifying bacteria not present to so great an extent in unheated soils. These authors' experiments show that the inhibition of the beneficial organisms in untreated soil is not due to a toxic substance, but that it is caused by the presence in untreated soils of large protozoan organisms which destroy the useful bacteria. Heat and antiseptics kill the protozoa and most of the bacteria, but the latter soon take a new lease of life from the unharmed spores, and finding themselves unattacked by their enemies, they reproduce in great numbers, meanwhile causing large increases in the soluble nitrogenous matter of treated soils. Experiments with crops demonstrated that the higher plants made growths on treated soils which were much better than on soils not treated. In summing up Russell and Hutchinson's work we may say that their idea is to credit the increased productiveness of heated and toluened soils to the consequent destruction of protozoa which in ordinary soils prey upon the beneficial ammonifying bacteria and nearly exterminate them.

Lyon and Bizzell[4] at the Cornell Experiment Station published

[3] Russell and Hutchinson: The effect of partial sterilization of soils on the production of plant food. Jour. Agric. Sci., 3: 111–144. 1909.

[4] Lyon and Bizzell: Effect of steam sterilization on the water-soluble matter in soils. Bull. 275. Cornell Experiment Station, Ithaca, N. Y. 1910.

a bulletin on the effects of steam sterilization, studying the chemical and agricultural phases rather than the bacteriological ones. Their soils were steamed for various periods of time in an autoclave under a pressure of two atmospheres. The water-soluble matter was greatly increased by this treatment, but upon standing untouched the soils gradually went back to their original state, at least as far as their soluble matter was concerned. These authors found that both ammonification and nitrification were absent for three months after heating. The extracts of these steamed soils were distinctly unfavorable to the growth of seedlings, but upon proper dilution the seedlings made a better growth than in extracts of unsteamed soils. They speak of the "injurious" results of steaming, but, of course, this term applies only when judged from the standpoint of the green plant. The lower fungi like *Pyronema* flourish on these extracts which are toxic to the seedlings of the higher plants. After standing three months the steamed soils made an excellent showing when planted with wheat. The fact that ammonification is at a standstill, and that such steamed soils are harmful to green plants immediately after this treatment, is probably attributable to the same cause, namely, the complete destruction of beneficial bacteria by the higher temperatures they employed. Russell and Hutchinson did not find this to be the case, probably because the temperature they used was sufficient to kill protozoa but not the spores of bacteria. This variation in temperature might well account for the differences in the results of these two groups of investigators. However, it is doubtful if it is correct to speak of the sterilization of a soil, since, as pointed out to us by Dr. Schreiner of the Bureau of Soils, it is impossible to say that the heat has entered the interior of the soil mass sufficiently to kill every living organism and spore. Fletcher[5] does not believe that the advantage of heating soils comes from changing the bacterial flora or increasing the soluble matter. He feels that the heat destroys some toxin present in the unheated soil. He heated soils to 95° and 170° C. and found that afterwards corn made a better growth upon both the heated soils than upon the unheated control. The work of other investigators and also our own does not agree with Fletcher's conclusion that soils heated to

[5] Fletcher: Effect of previous heating of the soil on the growth of plants and the germination of seeds. Cairo Science Jour., 4: 81–6. 1911.

a high temperature are favorable to an immediate growth of green plants.

Bolley[6] concludes that the destruction of the spores of disease-producing fungi and bacteria has more to do with the final increased productiveness on heated soils than has either the destruction of bacteria-loving protozoa, as claimed by Russell and Hutchinson, or the increase of soluble matter found by Lyon and Bizzell. There is undoubtedly considerable truth in this contention of Bolley. The authors of the present paper feel that the whole question of the effects of heating soils is a very complex one and one in which the experimenter's interpretation of results depends upon his training and point of view; whether it be bacteriological, chemical or phyto-pathological. It is very likely that the truth of the matter lies somewhere on the border-lines of the three sciences indicated.

PRACTICAL ASPECTS OF SOIL "STERILIZATION"

For some time a few gardeners and florists have found that heating the soil for the benches of their greenhouses seems to produce better plants, which were also free from the attacks of disease and from competition with weeds. In India, also, the Hindu farmers have long been in the habit of burning brush, cow-dung, etc., upon the surface of the rice seed-beds. They call this process "rab" and all speak highly of its efficacy in producing good crops. Mann[7] has discussed this practice and believes there are three main causes for its beneficial results: (1) Favorable changes in the bacterial flora of the soil; (2) organic nitrogenous matter is made more soluble; (3) the physical properties of the soil seem to be improved. Until within a few years the practice of heating soils in agricultural work had but few advocates; but now through the influence of the experiment stations and government bureaus it is being extended and applied in many directions.

Recently various bulletins and circulars have been published in different states and countries, advocating the "sterilization" of soils by heat, thereby freeing the crops from fungus and insect pests and also killing the seeds of weed plants. This treatment has been

[6] Bolley: Interpretation of results in experiments upon cereal cropping methods after soil sterilization. Science, 33: 229–34. 1911.

[7] Mann: Ann. Report of Dep't. of Agriculture, Bombay, pp. 50–4. 1908–9.

especially recommended in the case of seed-beds prepared for starting tobacco plants. Portable boilers with inverted pans and other apparatus for sterilizing the soil with steam have been described, and the results discussed in publications from the Connecticut Agricultural Experiment Station[8] and from the Bureau of Plant Industry at Washington.[9] In a bulletin[10] from South Africa the advantages of soil sterilization are called to the attention of the tobacco growers, the increase of plant food being especially noted. Burning brush or similar material upon the soil seems to yield better results than the use of steam. Now, in all these reports upon the favorable results of heating soils we find little reference made to any effects except the desirable ones of killing the spores of parasitic fungi, etc. The chemical changes that may be produced are almost wholly ignored, yet, even under the condition of the rather low heat obtained with the steaming apparatus, such changes apparently have a stimulative and beneficial action on the plants. Furthermore, we believe the almost universal practice of "sterilizing" the soil to be used in physiological and culture experiments should be applied with caution, and with due recognition that the resultant chemical changes in such soils may vitiate experimental results and prove more disconcerting than the undesirable factors in untreated soils.

Observers in certain districts in Maine and other parts of the country where blueberries flourish over large areas, have often noticed that when such areas have been recently burned over the growth was especially luxuriant. The Indians also noticed this phenomenon and so they occasionally set fire to large tracts of blueberry lands in order to encourage large crops of fruit in the following two or three summers. In northern New England, blueberries are picked in large quantities for canning, and in these districts the owners of blueberry pastures burn over one-third of such land every third year, thus burning over the whole once every three years.[11] The

[8] Hinson and Jenkins: The management of tobacco seed-beds. Bull. 166, Conn. Agric. Experiment Station, New Haven. 1910.

[9] Gilbert: The root-rot of tobacco caused by *Thielavia basicola*. Bull. 158, Bur. Plant Industry, Dep't of Agriculture, Washington. 1909.

[10] Scherffius: Sterilizing tobacco seed-beds. Agric. Jour. of Union of South Africa, 2: 418–31. 1911.

[11] Munson: The horticultural status of the genus *Vaccinium*. Bull. 76, Maine Agricultural Experiment Station, Orono. 1901.

attractiveness of the blueberry has often led to attempts to transplant and grow it under artificial conditions but failure usually followed. This was explained by assuming that the blueberry loved a peaty soil, a condition which could not be successfully imitated in gardens. However, Coville[12] has recently succeeded in growing the blueberry from seed and bringing it to full size and maturity. This was not done until a careful field study had shown that in nature this plant flourishes upon peaty soils which are *acid* in character. With this fact in mind Coville used well-drained acid soils, and by so doing he had unusual success in raising the blueberry. In the roots of the blueberry plant he discovered a mycorrhizal fungus that seemed to help supply the plant with nitrogenous food. In acid soils the ordinary nitrogen bacteria cannot develop, and this type of fungus may take their place in plants like the blueberry and the cranberry which thrive on acid peaty soils. In a later note Coville[13] reported that the Mayflower, or Trailing Arbutus, could be raised from seed when sown upon such acid soils, and could then be brought to a perfection of bloom seldom equalled in the wild state. We feel that there is some connection between these two observations that certain plants flourish upon acid soils and that many of the same kinds flourish on burned-over soils. In our earlier work we found that heating a soil produces in it easily soluble substances of acid reaction. It seems likely that burning over the underbrush on a soil renders it acid in reaction, and probably produces an artificially acid condition nearly as agreeable to certain plants as are the naturally acid peat soils. To test this point we now have experiments under way with seeds and cuttings of the blueberry, and also with the seeds of the Mayflower planted in soils rendered acid by heating.

ANALYTIC CHEMICAL STUDIES

In our previous paper the data for composition of the extracts of soils exposed to dry heat show that the amounts of soluble matter in the extracts are from six to ten times greater than in similar

[12] Coville: Experiments in blueberry culture. Bull. 193, Bur. of Plant Industry, United States Dep't of Agriculture, Washington. 1911.

[13] Coville: The use of acid soil for raising seedlings of the Mayflower, *Epigæa repens*. Science, 33: 711–2. 1911.

extracts of unheated soils. The organic matter thus made soluble is always greater in amount than the inorganic matter, but the latter is also considerably increased. We now turned our attention to a study of the effect of exposing the soil to different intensities of heat for the same period of time. The manner of handling the soil for these experiments was as follows: Ordinary loamy soil from this vicinity was placed in pots properly labeled with the various temperatures to which they were to be heated. They were all placed in a large hot-air sterilizing oven and were heated until the thermometer in the soil indicated 90°. This temperature was maintained for two hours, when the pot marked 90° was removed. The temperature was then increased to 120°, and maintained there for two hours, when the corresponding pot was taken out. This process was repeated in each case until the different series of heated soils were obtained. The extracts of the various soils were then prepared by percolating 3 kg. samples of the soils with about two liters of distilled water. We saved the first 350 c.c. that came through and used two 50 c.c. portions for the determination of soluble matter and total nitrogen. The remainder of each extract was reserved for cultural experiments with seedlings, etc.

TABLE I.

Effect of Different Temperatures upon the Soluble Matter in Soils

Nature of Soil	Total Solid Matter, Per Cent	Organic Matter, Per Cent	Inorganic Matter, Per Cent	Total Nitrogen, Per Cent
Unheated	0.030	0.020	0.010	0.0012
Heated to 90°	0.061	0.045	0.016	0.0016
Heated to 120°	0.117	0.092	0.025	0.0036
Heated to 150°	0.219	0.177	0.042	0.0092
Heated to 170°	0.275	0.184	0.091	0.0112

TABLE 2.

Conditions Similar to Those Stated in the Heading of Table 1

Nature of Soil	Total Solid Matter, Per Cent.	Organic Matter, Per Cent.	Inorganic Matter, Per Cent.	Total Nitrogen, Per Cent.
Unheated	0.030	0.015	0.015	0.0017
Heated to 90°	0.033	0.019	0.014	0.0022
Heated to 120°	0.049	0.034	0.015	0.0084
Heated to 170°	0.111	0.069	0.042	0.0106

To determine the soluble matter the 50 c.c. samples of each extract were evaporated to dryness in platinum dishes, dried at 108° to constant weight and this weight recorded as *total solids*. The residues were carefully ashed at a low red heat, dried and weighed again, and this weight recorded as *inorganic matter*. The difference between this weight and the weight of the total solids was recorded as *organic matter*. Total nitrogen was determined in another 50 c.c. portion by the official method for nitrogen, including that in the form of nitrates, etc.[14] The analytical results were very interesting. We give two typical series of such data in Tables 1 and 2.

From such figures one may conclude, as was done in our previous paper and in the papers of others, that dry heat causes the production in soils of large amounts of soluble material. The more striking fact is that the *increase of soluble matter goes hand in hand with the temperature to which the soil was subjected*. It occurred to us that the objection might be raised that in our experiments it was the *duration* of the heating rather than the temperature that caused the gradual increase of soluble matter in every one of our different series. To test this point we exposed one lot of soil to 120° for ten hours, and upon analysis of the extract it showed only a slight increase of soluble matter over the lot heated to 120° for two hours. The intensity of the heat seems to be the controlling factor in rendering the soil material more soluble. The organic matter, inorganic matter and total nitrogen all seem to be affected by the heat, but the organic matter and nitrogen show the greatest and most consistent increases. The color, odor and degree of contamination with *Pyronema, Penicillium,* etc., all show an increase parallel to the soluble matter indicated by analysis. In the next section our culture experiments show the same gradual change in the properties of the heated soil extracts dependent upon the degree of heating.

CHEMICAL NATURE OF THE SOLUBLE ORGANIC MATTER IN HEATED SOILS

We have already reported that the extracts of heated soils are acid to litmus, give the Molisch test for carbohydrates, reduce Fehling solution, and give a precipitate with lead acetate solutions.

[14] Official and provisional methods of analysis. Bull. 107 (rev.), Bur. of Chemistry, U. S. Dep't of Agriculture, Washington, 1908, p. 7, sec. (*c*).

This was the extent of our knowledge when we began the present study. Our first experiments were performed upon 200 c.c. of heated soil extract containing about 0.3 per cent. of total soluble matter. Its color was deep brown, its acidity was marked and it had an odor of burned sugar. To this hot extract an excess of basic lead acetate solution was added; this caused a heavy brown precipitate, which was filtered off and washed. The dark precipitate was suspended in distilled water and treated with hydrogen sulfid gas for the removal of the lead. The lead sulfid thus formed was filtered off and the clear brown filtrate was boiled to expel the excess of hydrogen sulfid. The filtrate after the removal of the first lead precipitate was yellowish and it, too, was saturated with hydrogen sulfid to remove the excess of lead. The lead sulfid was removed by filtration. The two solutions now free from both lead and hydrogen sulfid were then subjected to the tests indicated below:

	Molisch Test	Fehling–Benedict Solution	Alkaline Silver Solution	Color	Odor
Material *precipitated* by basic lead acetate...	Very strong	Reduction	Reduction	Brown	Sharp, caramel-like
Material *not precipitated* by basic lead acetate.....	Doubtful	Negative	Reduction	Yellowish	Sweet, not sharp

The solution of the material precipitated by basic lead acetate deposited a crystalline powder upon spontaneous evaporation to dryness. These crystals were insoluble in 95 per cent. alcohol, which dissolved the brownish coloring matter mixed with them. This treatment might afford a means of separating these substances. Dialysis through collodion membranes did not produce any separations in any of our chemical work upon any of the various soil extracts.

We next obtained a large volume of heated soil extract (2.25 l.) and added to it *normal* lead acetate solution until no more precipitate was produced. This precipitate was filtered off and *basic* lead acetate solution added to the filtrate until no further effect was produced. In this case the addition of the basic salt caused a precipi-

tate which became lighter in color with each successive addition. This precipitate was removed by filtration and the clear yellow filtrate was saturated while hot with hydrogen sulfid. This was also done with suspensions of each of the two precipitates already obtained. The lead was removed as sulfid and the excess of hydrogen sulfid was boiled out. The three purified solutions were tested as follows, with the results indicated:

	Molisch Test	Fehling–Benedict Solution	Alkaline Silver Solution	Color	Odor
Material precipitated by *normal* lead acetate...	Weak	Reduction (?)	Reduction	Brown	Sharp
Material precipitated by *basic* lead acetate...	Very strong	Reduction	Reduction	Brown	Sweet
Material precipitated by *neither* reagent.	Very strong	Reduction (?)	Heavy precipitate	Light yellow	Sweet

Note. An attempt was made to prepare osazones from the solutions by the customary use of phenyl hydrazine and sodium acetate but dark amorphous products were always obtained.

The three solutions obtained, as described in the last paragraph, from the basic lead acetate precipitate, the normal lead acetate precipitate, and the final filtrate, were all evaporated to small bulk. With these solutions various attempts to make separations were ineffectual until we found that the addition of an alcohol-ether mixture or acetone produced light flocculent precipitates. Acetone yielding better results, we used it upon larger volumes of the three solutions. The acetone produced buff-colored precipitates of great bulk but containing little material when dry. They dissolved easily in distilled water. Such solutions showed little if any reduction of Fehling-Benedict solution, but gave strong Molisch tests in all cases. They gave reddish brown colorations with dilute solutions of iodin with potassium iodide.

From these chemical observations, then, it seems likely that the organic material in heated soil extracts consists mostly of carbohydrate-like substances, probably derived from the cellulose remains of previous plant growth upon the soil. Whatever may be the

source of this material it seems to show properties of sugars and also of organic acids. The cellulose or humus substance seems to be changed by the heat into a series of decomposition products having the groups characteristic of sugars and also of organic acids. Precipitation with normal lead acetate and then with the corresponding basic salt produces a partial separation of these substances, as also does the addition of acetone. The relation of this organic material to the constituents of caramelized sugar would make an interesting study.

CROP EXPERIMENTS

Many experiments with the fungus *Pyronema* had shown that the stronger the extracts of heated soils the better media they were for this fungus. Other authors had reported that the green plants did not take kindly to soils which had been heated to a high temperature. From the above observations it occurred to us that the harmful effects from the heating of the soil in which certain plants are grown might not be due to the fact that the materials rendered available by heating are especially harmful, but that they are formed in such large quantities that the green plant is unable to use them. This view is strengthened by the experience of Livingston[15] and others that growth is accelerated in weak solutions and retarded in concentrated ones. On the other hand, the lower plants such as yeast and fungi are able to grow in solutions that would very rapidly plasmolyze the cells of the higher plants.[16] Evidently, then, the osmotic pressure of their cells must be in equilibrium with that of their medium. In order to test this conception as applied to our problem it was decided to try the effect of the growth of a given plant on the same kind of soil heated to different temperatures. In looking about for a plant to be used in these preliminary experiments, the common oat (*Avena sativa*) was selected for the reason that it had been previously observed that the burning over of the surface of the soil seemed to accelerate the growth of this particular crop.

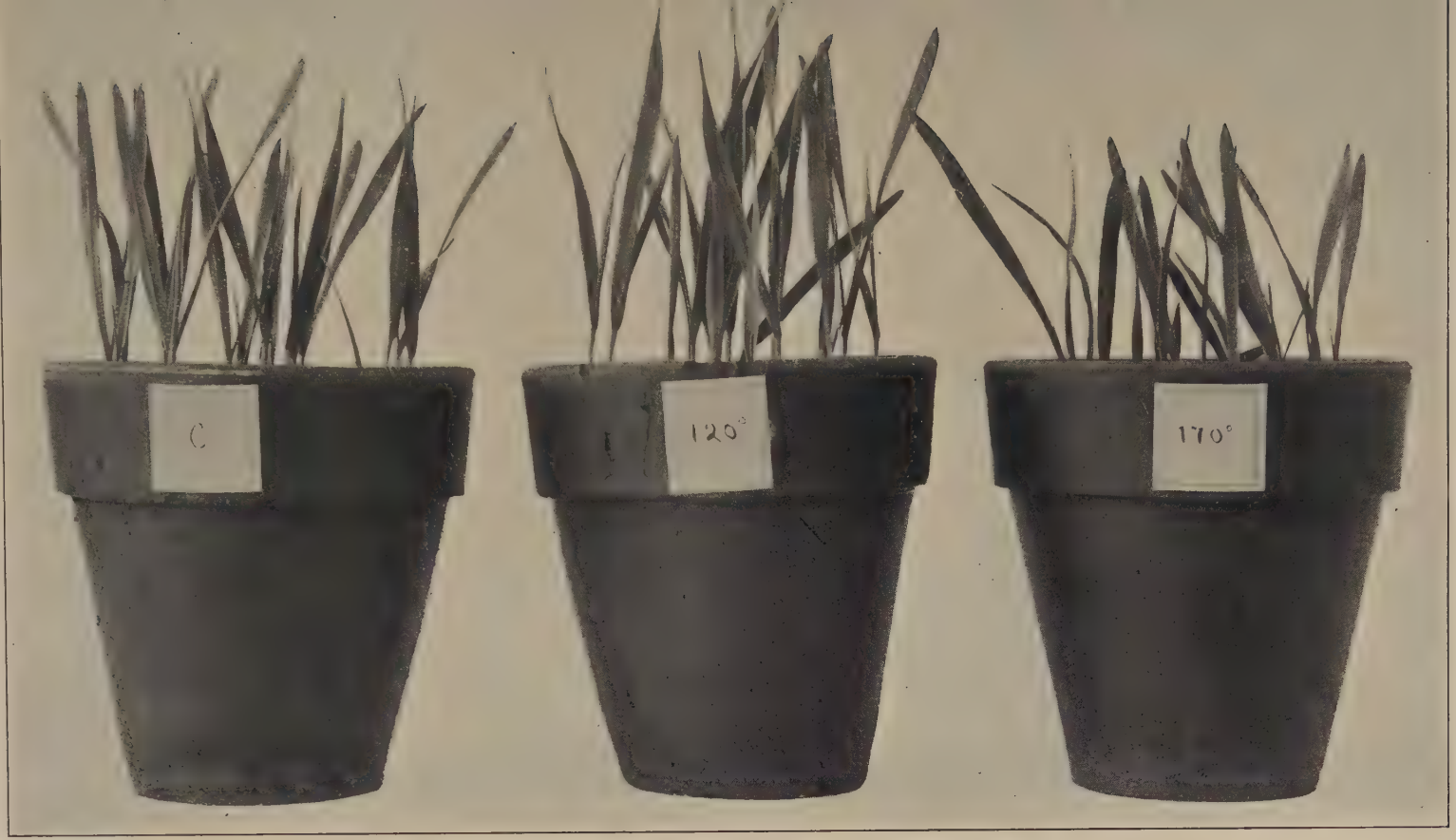
[15] Livingston: The rôle of diffusion and osmotic pressure in plants, pp. 124–144. 1903.

[16] This matter is discussed in Jost's (Gibson translation) Plant Physiology, p. 179. 1907.

Experiment I. Ten pots of common unfertilized New York soil were prepared; two of these were kept as controls and two heated to a temperature of 90° C. for two hours, two to a temperature of 120° for the same length of time, two to 150° and two to 170° C. From one series of pots, extracts were taken by percolating equal amounts of distilled water through each pot. Approximately the same amount came through in each case. One hundred c.c. were taken from each pot to be used for analytical purposes. As has been previously noted, the extracts of heated soils are of a brown color. In this series of experiments it was observed that the color varied directly with the temperature; the control being colorless, the extract from the soil heated to 90° being slightly colored, the color becoming deeper in each case as the temperature increased. The results of the chemical analyses of these extracts are given in Table I (page 419).

The other series of pots of soil which had been similarly heated, but not extracted, were watered and planted with oats, the same number of seeds having been placed in each pot. After about two weeks the following results were obtained: the control and pot of soil heated to 90° showed practically the same growth; that heated to 120° showed considerable acceleration; and beyond this the growth was retarded, the retardation in the pot heated to 150° and that heated to 170° being nearly equal. The accompanying photograph (Plate VII) shows the control, the pot heated to 120° C. and that heated to 170°, the contrast being greatest at these points.

Experiment II. In order to check the results obtained in one of the experiments just described, a second series of pots of ordinary New York soil were set up and heated in the manner already stated. In this case the series consisted of an unheated control, and three others heated to 90°, 150° and 180° C. respectively. Oats were planted as usual and their condition noted, after germination and about two weeks' growth had been made. In this series the soil heated to 120° did not show the slight gain over the unheated control that was noted in the earlier experiments, but the higher temperatures produced the same retarding effects already found. In this and previous experiments the soils heated to 120° and above



SEAVER AND CLARK: GROWTH IN HEATED SOILS.

Left to right: Oats grown in unheated soil, in soil heated at 120° C., and in soil heated at 170° C.

were very soon covered with a luxuriant web of mycelium of *Pyronema* which produced its salmon-colored fruiting bodies and then disappeared. This is another illustration of the fact that conditions of media entirely unsuited for green plants may be highly favorable to fungi. One should be careful not to speak of "toxic" or "poisonous effects" unless the organism is mentioned to which such reference is made.

The cultural experiments just outlined show that heating soils to temperatures above 120° seems to produce effects unfavorable to the growth of oats, while heating to less than 120°, depending, of course, upon the crop and soil used, seems to be slightly beneficial or, at any rate, not definitely harmful. The harmful effects on green plants and the beneficial effects on fungi seem to increase, hand in hand, with the intensity of the heat. This may indicate that both effects are due to the relative *amounts* of substances in solution and not to their so-called harmful or beneficial nature. This parallelism is so complete that it does not seem likely that the effects of heating soils are mainly due to the destruction of *living organisms*—the protozoa mentioned by Russell and Hutchinson or the spores of harmful fungi according to Bolley. In other cultural studies we made extracts of similar series of heated soils for chemical analysis and for culture solutions in lupin experiments now to be outlined.

THE EFFECTS OF SOIL EXTRACTS UPON LUPIN SEEDLINGS

After satisfying ourselves that strongly heated soils were distinctly harmful to the growth of oats upon them, we then used extracts from series of soils heated to different temperatures for equal periods of time as culture solutions for lupin seedlings. These seedlings had been started in germinators filled with sphagnum moss and the radicle allowed to reach a length of 3–5 cm. The seedlings were placed in Jena beakers containing 200–300 c.c. of the extracts to be studied. They were placed on glass rods in lots of four in each extract after the manner described by True and Gies.[17] All measurements are given in millimeters of growth in the designated time and represent the average for *four* seedlings (Table 3).

[17] True and Gies: On the physiological action of some of the heavy metals in mixed solutions. Bull. Torrey Botan. Club, 30, 390. 1903.

TABLE 3. EXPERIMENT I. STARTED MAY 5, 1911

Growth, in Millimeters, of Lupin Seedlings in Soil Extracts

Nature of Extract	May 6	May 8	May 9	May 11
Unheated soil	15	43	15	28
Heated to 90°	15	48	12	24
Heated to 120°	10	24	8	11
Heated to 170°	7	17	3	4

Note. For analytic data pertaining to these extracts see page 419 (Table 2).

The appearance and growth of the lupins in the unheated soil extract and the 90° soil extract were apparently normal in every way. However, in the extracts of the 120° and 170° soils the opposite was true. The white roots very rapidly became brownish in color and the formation of secondary roots was almost entirely prevented. Such lupins looked like similar ones acted upon by toxic though minute amounts of copper. The results of another typical experiment upon the effects of the soil extracts are given below.

TABLE 4. EXPERIMENT II. STARTED APRIL 7, 1911

Growth, in Millimeters, of Lupin Seedlings in Soil Extracts

Nature of Extract	April 8	April 10	April 11	April 13
Unheated soil	7	24	16	26
Heated to 90°	5	22	15	26
Heated to 120°	2	16	12	20
Heated to 170°	4	12	8	12

Note. Whenever the extracts of heated soils were to be preserved for analysis or seedling studies, it was found necessary to seal them in glass-stoppered bottles while boiling hot.

A glance at the results of our seedling experiments (Tables 3 and 4) shows that, with slight exceptions due to experimental errors, the soils heated to temperatures in the vicinity of 120° to 170° C. contain substances soluble in water which exert a strong inhibitory effect upon lupin seedlings grown in such solutions. The results of our oat culture work are in harmony with the idea, which Lyon also held, that strong heating produces soluble material harmful to green plants. The fact that extracts used for the seedling studies, and the extracts from the oat culture soils, were analyzed and found to have quantitative relations depending on the intensity of the heat, seems to indicate that the causes are to be found in *chemical* changes rather than changes in the soil flora, and so on.

SUMMARY OF CONCLUSIONS

1. The color of the extracts of heated soils varies with the temperatures to which the soils have been subjected; the extract of unheated soil being colorless, that of soil heated at 90° C. being slightly yellowish, that of soil heated at 120° C. being more deeply colored.

2. The amount of soluble matter in the soil also varies with the temperature to which the soil has been exposed and to this the color of the extracts serves as an index; the deeper the color the more soluble matter the extracts contain.

3. The length of time during which the soil has been exposed seems to be of little moment; soil heated at 120° C. for ten hours containing little more soluble matter than the same soil heated at the same temperature for only two hours.

4. Growth of the *green plants* used by us is slightly accelerated in soils heated at low temperatures (90–120° C.) but above this point growth is retarded, the retardation increasing with the temperature to which the soils have been exposed.

5. Retardation seems not to be due to the toxic effects of the substances rendered soluble, but to the fact that they are present in such large quantities that the plant is unable to absorb them.

6. The influence of heated soils on the growth of *fungi* is the opposite of that on the growth of green plants, the growth becoming more luxuriant as the temperature is increased. This can be explained by the fact that fungi, unlike most green plants, have the power of adapting themselves to nutrient media of a comparatively high degree of concentration.

7. The beneficial or harmful results, therefore, of the heating of a soil for the growth of plants, depends upon the temperature to which the soil has been heated as well as upon the nature of the soil and the plant.

8. The preference of certain plants for burned-over areas or for peaty soils may be explained by the acidity of such situations, a supposition we are testing by blueberry culture experiments now under way.

Finally, we wish to express our thanks to Professor William J. Gies for his helpful suggestions during the course of our investigations.

No 25

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THE GENUS LASIOSPHAERIA

Fred J. Seaver

(With Plates 66 and 67, Containing 37 Figures)

In working over the Trichosphaeriaceae preparatory to a monograph of the family a number of points of interest have arisen relating both to genera and species. In order to bring out some of these points the North American species of the genus *Lasiosphaeria* are here described and illustrated.

The genus *Lasiosphaeria* was founded in 1863 by Cesati and De-Notaris, with *Sphaeria ovina* Pers. as type of the genus. In 1869 Fuckel took up the genus *Leptospora* Rabenh. but used it in a different sense from that in which it was originally used by Rabenhorst,[1] including *Sphaeria ovina* Pers. in this genus. In the diagnosis of the genus *Leptospora* Fuckel states: "Diese Gattung steht, was den Sporenbau anbelangt, *Lasiosphaeria* nahe, nur sind bei *Leptospora* die Sporen ohne Querwänden." In the members of this group of plants it is very difficult to rely upon the septation of the spores as a basis for generic distinction since in many species the spores are nonseptate when young and it is difficult to find mature spores, but when mature spores are found, they are often delicately separate. The type of the genus *Lasiosphaeria* as usually collected has nonseptate vermiform spores while rarely plants of the same species are found with some of the spores enlarged at one end into an ellipsoid head and becoming one or more septate. Other species of the genus which usually contain nonseptate spores occasionally have the spores septate without enlargement, the number of septa varying with the species. While Fuckel in his diagnosis of the genus *Leptospora* regards the spores as nonseptate he includes in the genus species in which, as described above, the spores are often septate. The genus *Leptospora* of Fuckel is therefore regarded as a synonym of *Lasiosphaeria*, in which genus the presence or absence of septa is a variable character.

[1] Hedwigia 1: 116. 1857.

Since the genus *Lasiosphaeria* was founded numerous species have been placed in the genus which more properly belong with other genera of the Trichosphaeriaceae. The genus, therefore, as here treated is used in a somewhat restricted sense to include the species which, in the judgment of the writer, properly belong here. While as a rule the members of the genus have hairy perithecia in a few the perithecia are not conspicuously hairy at least when old. The delicate walled, long and usually vermiform spores constitute one of the most valuable diagnostic characters of the genus.

So far as the form and variability of the spores is concerned this group shows a very close relationship with the Fimetariaceae (Sordariaceae), the chief difference being in the consistency of the perithecia which may be due in part at least to the difference in substratum. Referring to *Pleurage albicans,* Griffiths[2] says: "A very interesting species from the fact that mature spores are seldom met with. . . . Often one may find asci in which the spores are slightly enlarged at the end, but it is seldom that they can be found in even the olive-green stage. In the vast majority of cases they are simply the long cylindrical curved guttulate structures that are the forerunners of the spores of so many of the species of the genus." The same statement will apply equally well to several species of the genus *Lasiosphaeria* as shown by the illustrations accompanying the present paper. While *Pleurage lutea* (Ellis & Ev.) Kuntze which occurs on wood is commonly placed with the Fimetariaceae it is doubtful whether it should not more properly have been placed in the genus *Lasiosphaeria* with the family Trichosphaeriaceae. As a whole the present genus shows a rather close relationship with the genus *Pleurage* of the Fimetariaceae.

As the present paper is preliminary to a treatment of the family Trichosphaeriaceae in North American Flora, any data regarding additional species in the genus *Lasiosphaeria* or notes regarding the extension of range of distribution of any of the species here described will be very gladly received.

[2] North American Sordariaceae. Mem. Torrey Club 11: 80. 1901.

LASIOSPHAERIA Ces. & De-Not. Comm. Soc. Critt. Ital. 1: 229. 1863

Leptospora Fuckel, Symb. Myc. 143. 1869. ?Not *Leptospora* Rabenh. 1857.

Perithecia superficial, free or seated in a subiculum consisting of a black or dark brown mycelial growth, cylindric, globose, ovoid or pyriform, brownish or blackish or occasionally light colored by reason of the pale hairs with which they are clothed, or clothed with black hairs; hairs rigid or flexuous, few or abundant; asci cylindric or clavate, usually 8-spored; spores very variable, usually vermiform with a delicate appendage at either end, hyaline or colored a part of their length, or often with an enlarged head which may be hyaline or dark brown in color, simple at first but often becoming at maturity delicately septate; septa variable in number or in some species constant.

Type species, *Sphaeria ovina.*

Spores uniformly hyaline or subhyaline throughout their entire length.
- Perithecia clothed with light colored hairs giving them a grayish or yellowish appearance.
  - Hairs scant, flexuous, varying from yellowish to whitish. — 1. *L. mucida.*
  - Hairs abundant, rigid, giving the perithecia a spiny appearance.
    - Neck of the perithecia simple. — 2. *L. strigosa.*
    - Neck of perithecia compound, four-parted. — 3. *L. stuppea.*
- Perithecia clothed with black hairs.
  - Perithecia subglobose to pyriform.
    - Hairs abundant, rigid, giving the perithecia a spiny appearance.
      - Spores 50–80 × 6 μ, becoming 7-septate.
        - Plants occurring on wood. — 4. *L. hispida.*
        - Plants occurring on soil. — 5. *L. terrestris.*
      - Spores 65–70 × 3–4 μ, becoming many-septate. — 6. *L. multiseptata.*
    - Hairs scant, spores small, 20 × 4 μ. — 7. *L. globularis.*
  - Perithecia flat below, depressed-conic. — 8. *L. jamaicensis.*

Spores dark brown a part of their length.
- Colored portion of spore enlarged into an ellipsoid head. — 9. *L. newfieldiana.*
- Colored portion of spore not enlarged. — 10. *L. dichroöspora.*

1. **Lasiosphaeria mucida** (Tode)

Sphaeria mucida Tode, Fungi Meckl. **2**: 16. 1791.
Sphaeria mutabilis Pers. Ic. Descr. Fung. 24. 1798.
Sphaeria ovina Pers. Syn. 71. 1801.
Leptospora ovina Fuckel, Symb. Myc. 143. 1869.
Lasiosphaeria ovina Ces. & De-Not. Comm. Soc. Critt. Ital. **1**: 229. 1863.

Perithecia superficial, gregarious or often crowded, nearly globose with a more or less prominent ostiolum, about .5 mm. in diameter, clothed externally with a fine white or yellowish tomentum except the ostiolum which appears as a black dot, the entire perithecium becoming darker with age, at length brownish or blackish, hard and carbonaceous; asci cylindric or clavate, 8-spored, surrounded by a yellow mucilaginous substance, 150–200 × 15–20 μ; spores cylindric, or vermiform, usually abruptly curved near the lower end, hyaline, simple or indistinctly septate or pseudoseptate, often with a delicate appendage at either end and occasionally with one end swollen forming a conspicuous head, 35–50 × 3–5 μ (*pl. 2, f. 1–3*).

On rotten wood.

TYPE LOCALITY: Mecklenburg, Germany.

DISTRIBUTION: Maine to Colorado, Florida and Louisiana.

ILLUSTRATIONS: Tode, Fung. Meckl. *pl. 10, f. 82;* Pers. Ic. Descr. *pl. 7, f. 6.*

EXSICCATI: Ellis, N. Am. Fungi *892.*

2. LASIOSPHAERI STRIGOSA (Albert. & Schw.) Sacc. Syll. Fung. **2**: 201. 1883

?*Sphaeria canescens* Pers. Obs. Myc. **8**: 67. 1796.
Sphaeria strigosa Albert. & Schw. Consp. Fung. 37. 1805.
Leptospora strigosa Fuckel, Symb. Myc. 144. 1869.
?*Lasiosphaeria canescens* Karst. Myc. Fenn. **2**: 162. 1873.
?*Sphaeria sublanosa* Cooke; Cooke & Ellis, Grevillea **7**: 41. 1878.
?*Metasphaeria sublanosa* Sacc. Syll. Fung. **2**: 165. 1883.
Lasiosphaeria Hystrix Ellis & Ev. Proc. Acad. Nat. Sci. Phil. **1894**: 326. (1895?)

Perithecia thickly gregarious and occasionally crowded, subglobose to ovoid, black, clothed externally with stout rigid yellowish hairs; hairs acute or subacute, 12–14 μ in diameter near the

base with a narrow cavity extending longitudinally through the center, pale yellow with the microscope; asci clavate, 8-spored, about 100 × 15–18 μ; spores 2-seriate or irregularly crowded, cylindric or cymbiform with acute ends, hyaline or pale yellowish, 25–30 × 5–6 μ, granular within and often pseudoseptate near the center (*pl. 1, f. 4–7*).

On rotten wood.

TYPE LOCALITY: Europe.

DISTRIBUTION: New Jersey to Ontario and Ohio.

ILLUSTRATIONS: Albert. & Schw. Consp. *pl. 5, f. 7;* Berl. Ic. Fung. 1: *pl. 107, f. 2.*

3. LASIOSPHERIA STUPPEA Ellis. & Ev. Bull, Washburn Lab. Nat. Hist. 1: 4. 1884

Perithecia superficial, gregarious, ovoid, about 1 mm. in diameter, densely clothed with light brown hairs; hairs simple, flexuous, blunt, with small central cavity, pale yellowish with transmitted light, 200–400 μ long and about 6 μ in diameter; ostiolum strongly 4-ribbed giving the appearance of a cluster of four perithecia imbedded in a stroma; asci clavate, 8-spored, 18–20 μ in diameter and about 200 μ long; spores partially 2-seriate, elongate-ellipsoid, 30–38 × 8–10 μ, hyaline or slightly yellowish at maturity, with 1–3 oil-drops (*pl. 1, f. 8–11*).

On dead wood of *Tsuga Pattoniana.*

TYPE LOCALITY: Mt. Paddo, Washington.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATION: Ellis & Ev. N. Am. Pyrenom. *pl. 19, f. 5–10.*

4. LASIOSPHAERIA HISPIDA (Tode) Fuckel, Symb. Myc. 147. 1869

Sphaeria hispida Tode, Fungi Meckl. 2: 17. 1791.

Sphaeria Rhacodium Pers. Syn. Fung. 74. 1801.

Sphaeria hirsuta Pers. Ann. Bot. Usteri 11: 24. 1794.

Sphaeria emergens Schw. Trans. Am. Phil. Soc. II. 4: 212. 1832.

Lasiosphaeria hirsuta Ces. & De-Not. Comm. Soc. Critt. Ital. 1: 229. 1863.

Lasiosphaeria Rhacodium Ces. & De-Not. Comm. Soc. Critt. Ital. 1: 229. 1863.

? *Sphaeria orthotricha* Berk. & Curt. Grevillea 4: 108. 1876.

Perithecia gregarious, seated on a more or less well developed subiculum consisting of a black mycelial growth, ovate to pyriform, black, roughened and abundantly clothed with hairs; hairs black to the unaided eye, very dark brown with the microscope, long and flexuose near the base and shorter and more or less rigid above, blunt or subacute, simple or sparingly septate, the shorter hairs about 50–80 μ in length and 6 μ in diameter, quite variable in length; substance of the perithecium tough, black and opaque; asci cylindric or clavate, 8-spored; spores 2-seriate or irregularly crowded, long vermiform, often abruptly curved near one end, hyaline, becoming pale brown with 8–10 large distinct oil-drops, for a long time simple, finally becoming delicately 6-7-septate, usually with one septum between each two oil-drops, 50–80 × 6–8 μ (*pl. 2, f. 1–7*).

On rotten wood.

TYPE LOCALITY: Mecklenburg, Germany.

DISTRIBUTION: New York to Montana, Colorado and Alabama.

ILLUSTRATIONS: Tode, Fungi Meckl. **2**: *pl. 10, f. 84*; Rabenh. Krypt. Fl. **1**[1]: 194, *f. 1–3*.

EXSICCATI: Ellis, N. Am. Fungi *893;* Ellis & Ev. Fungi Columb. *116, 3314;* Shear, N. Y. Fungi *359*.

5. LASIOSPHAERIA TERRESTRIS (Sow.) de Thüm. Myc. Univ. 1744. 1881

Sphaeria terrestris Sow. Brit. Fungi *pl. 373, f. 7*.

Perithecia scattered or gregarious, black or brownish black, nearly globose, about .5 mm. in diameter, clothed externally with a rather dense covering of rigid black hairs; hairs 7–8 μ in diameter at the base, rather blunt and about 200 μ long; asci clavate, 8-spored; spores vermiform, crowded in the ascus, 65–70 × 6 μ, hyaline, multiguttulate, often with the end enlarged, becoming pale brownish at maturity and with several delicate septa (*pl. 2, f. 10–12*).

On soil.

TYPE LOCALITY: Great Britain.

DISTRIBUTION: Ohio; also in Europe.

ILLUSTRATION: Sow. Brit. Fungi *pl. 373, f. 7*.

6. **Lasiosphaeria multiseptata** Earle sp. nov.

Perithecia as in *Lasiosphaeria hispida;* spores long vermiform, slender, at first with numerous oil-drops, later becoming (many-

septate?), occasionally with one end of the spore enlarged forming a conspicuous head, 60–70 × 3–4 μ (*pl. 2, f. 8–9*).

Type collected on rotten wood of *Hicoria* at Tuskegee, Alabama, July 29, 1897, G. W. Carver *313* (herb. N. Y. Bot. Garden).

DISTRIBUTION: Alabama and Carolina.

EXSICCATI: Rav. Fungi Car. Exsicc. **5**: *66* (as *Sphaeria Rhacodium*).

The material from which the above species is described was labeled "sp. nov." in the herbarium of the New York Botanical Garden, and while closely related to *Lasiosphaeria hispida* seems to differ in the more slender spores which are multiguttulate and finally (many-septate ?) with the upper end occasionally enlarged into a conspicuous head.

In looking over the specimens under the name of *Lasiosphaeria hispida* several were found which agree with the one described here. Whether the enlargement of the end of the spore is a variable character as has already been noted in *Lasiosphaeria mucida*, I am unable to determine, but it is possible that this may be found to be the case.

7. **Lasiosphaeria globularis** (Batsch)

Sphaeria globularis Batsch, Elench. Fung. Cont. 1: 271. 1786.
Sphaeria spermoides Hoffm. Veg. Crypt. 2: 12. 1790.
Lasiosphaeria spermoides Ces. & De-Not. Comm. Soc. Crit. Ital. 1: 229. 1863.
Leptospora spermoides Fuckel, Symb. Myc. 143. 1869.
? *Hypoxylon miliaceum* Bull. Herb. Fr. *pl. 444*.

Perithecia sessile, usually thickly crowded forming a compact mass somewhat resembling a *Hypoxylon*, often several cm. in diameter, at first cylindric, becoming subglobose, often so closely crowded as to become irregular in form from mutual pressure, black, 1 mm. high and .5 to 1 mm. in diameter, ostiolum only slightly prominent, slightly hairy becoming naked with age and minutely rough, very hard and carbonaceous; asci cylindric, 8-spored; spores cylindric, slightly curved, 20–27 × 4 μ, hyaline (*pl. 1, f. 16–18*).

On old wood.

TYPE LOCALITY: Germany.

DISTRIBUTION: Newfoundland to New York.

ILLUSTRATIONS: Batsch, Elench. Fung. l. c. *pl. 30, f. 180;* Rabenh. Krypt. Fl. 1^2: 195, *f. 1–3;* Engler-Prantl, Nat. Pfl. 1^1: 397, *f, 256,* A–B.

8. **Lasiosphaeria jamaicensis** sp. nov.

Perithecia thickly gregarious, depressed, subconic, flattened below so as to appear to be partially immersed in the substratum but in reality entirely superficial, when removed leaving a ring-like scar 1 mm. across, the diameter of the base of the perithecium, ostiolum large, circular and rather prominent, the entire perithecium covered with a brownish floccose coat or entirely black, sparingly clothed with delicate erect bristles which also occur on the substratum surrounding the perithecia; hairs very dark brown or blackish, septate, rather blunt, 10–12 μ in diameter at the base; asci clavate, 8-spored; spores vermiform with blunt ends, abruptly bent near the center, 8-guttulate, becoming 7-septate, subhyaline or slightly yellowish, 50–60 $\times$ 7 μ; paraphyses numerous and filiform (*pl. 1, f. 1–3*).

Type collected on the stem of some unknown plant (probably a palm) at Castle Gardens, Jamaica, December 14–15, 1908, by W. A. and Edna L. Murrill, *127* (herb. N. Y. Bot. Garden).

DISTRIBUTION: West Indies.

9. LASIOSPHAERIA NEWFIELDIANA Ellis & Ev. N. Am. Pyrenom. 150. 1892

? *Lasiosphaeria ambigua* Sacc. Michelia 1: 46. 1879.

Perithecia gregarious, superficial, at first depressed, becoming ovoid or subconic, about .5 mm. broad and as large as 1 mm. in height, clothed with soft brown hairs and seated on a dense brown mycelial growth consisting of the same kind of hairs; hairs brown, septate, about 4 μ in diameter; asci cylindric, 8-spored; spores vermiform, at first hyaline, 35 $\times$ 4 μ, with a short apiculus at each end, the upper end finally enlarged into an ellipsoid, brown head; at maturity the spore consisting of the brown head 15–17 $\times$ 6–7 μ with a cylindric hyaline appendage 3 $\times$ 20 μ at the base, and a slightly shorter, much more slender appendage, 1–2 μ in diameter at the apex (*pl. 1, f. 12–15*).

On rotten wood.

TYPE LOCALITY: Newfield, New Jersey.

DISTRIBUTION: New Jersey to Ohio.

10. LASIOSPHAERIA DICHROÖSPORA Ellis & Ev. Erythea 1: 197. 1893

Perithecia densely gregarious, ovoid, rugose, black, tough-membranaceous, clothed with a few slender brown hairs; ostiolum broad convex-papilliform, sometimes subcompressed; asci lanceolate, 150 × 8-10 μ, 8-spored; spores 2-seriate, cylindric, bent near the lower end and hyaline below for about one third the length of the spore, abruptly black above, each end mucronately pointed, about 40–60 × 4–6 μ (*pl. 2, f. 13–15*).

On clay loam in woods.

TYPE LOCALITY: Seattle, Washington.

DISTRIBUTION: Known only from the type locality.

EXCLUDED SPECIES

Lasiosphaeria striata Ellis & Ev. Proc. Acad. Nat. Sci. Phil. 1893: 443. This species was described from material collected on willow limbs near Park Hill, Ontario, Canada, May 1893 by J. Dearness. The plant is a discomycete belonging to the genus *Godronia* and is apparently identical with *Godronia Betheli* Seaver which was described from material collected on branches of willow in the Rocky Mountains of Colorado. The small cups are constricted at their mouths and when dry collapse so as to give the appearance of perithecia which probably accounts for the fact that they were placed in the genus *Lasiosphaeria* by Ellis. The species would then be *Godronia striata* (Ellis & Ev.) Seaver with *Godronia Betheli* Seaver as a synonym.

EXPLANATION OF PLATE LXVI

Spores and asci drawn with camera lucida to a common scale.

Figs. 1–3. *Lasiosphaeria jamaicensis* Seaver. 1. Perithecia about natural size. 2. Perithecia enlarged. 3. Ascus and spores.

Figs. 4–7. *Lasiosphaeria strigosa* (Albert. & Schw.) Sacc. 4. Perithecia about natural size. 5. Perithecia enlarged. 6. Ascus with spores.

Figs. 8–11. *Lasiosphaeria stuppea* Ellis & Ev. 8. Perithecia about natural size. 9. Perithecia enlarged. 10. Ascus with spores. 11. Hair from perithecium.

Figs. 12–15. *Lasiosphaeria newfieldiana* Ellis & Ev. 12. Perithecia about natural size. 13. Perithecia enlarged. 14. Ascus with immature spores. 15. Ascus with mature spores.

Figs. 16–18. *Lasiosphaeria globularis* (Batsch) Seaver. 16. Perithecia about natural size. 17. Perithecia enlarged. 18. Ascus with spores.

EXPLANATION OF PLATE LXVII

Spores and asci drawn with camera lucida to a common scale.

Figs. 1–7. *Lasiosphaeria hispida* (Tode) Fuckel. 1. Perithecia about natural size. 2. Hair from base of perithecium. 3 and 4. Perithecia enlarged. 5. Ascus with spores. 6. Spore showing septa. 7. Hairs from perithecia.

Figs. 8–9. *Lasiosphaeria multiseptata* Earle. 8. Ascus with spores. 9. Spores showing enlarged head.

Figs. 10–12. *Lasiosphaeria terrestris* (Sow.) deThüm. 10. Perithecia about natural size. 11. Perithecia enlarged. 12. Ascus with spores.

Figs. 13–15. *Lasiosphaeria dichroöspora* Ellis & Ev. 13. Perithecia about natural size. 14. Perithecia enlarged. 15. Ascus with spores.

Figs. 16–19. *Lasiosphaeria mucida* (Tode) Seaver. 16. Perithecia about natural size. 17. Perithecia enlarged. 18. Ascus with immature spores. 19. Ascus with spores showing enlarged heads.

LASIOSPHAERIA

LASIOSPHAERIA

Wound caused by the larva of the leopard-moth in the trunk and branches of the silver-maple; left, side view of a burrow with the larva in place; right, face view of a similar wound in a smaller branch. Reduced nearly one-half.

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THE LEOPARD-MOTH.

WITH PLATES C, CI AND CII.

Like many of our most destructive plant parasites this insect was introduced into this country from Europe. Its presence was reported in Brooklyn about twenty years ago, and a little later its destructive work was discovered in Central Park, New York. It is now thoroughly established in the East and is the most destructive of the wood-borers both on account of the extent of the damage accomplished by each individual and by reason of the large number of ornamental trees and shrubs which it attacks.

The larva of this moth has been known and combatted to some extent in the New York Botanical Garden for several years, but it is only recently that the identity of the insect has been recognized. Since the identity and habits of any parasite must be known before it can be combatted intelligently the object of the present paper is to recall what is known of the habits of this insect and to call the attention of the public to the amount of damage which is accomplished by it with the hope of impressing upon them the necessity of the employment of more thorough means of suppressing the pest.

LIFE HISTORY.

The larvae upon hatching make their way to the smaller branches, usually a crotch, and bore into the tissues of the host, increasing rapidly in size. At maturity the larva attains a length of two inches, and is a nearly cylindrical white grub with a brownish-black head and posterior segments. The larva may

be known by its large size and by the markings which consist of a number of black dots on each of the main segments, usually a pair on each side and two pairs near the dorsal side.

Several writers have called attention to the migratory habits of the larva when partly grown; leaving the smaller branch in which it begins its work it proceeds to a larger branch, or in the case of comparatively young trees to the main trunk Here it bores out a large cavity often an inch wide and several inches long just under the bark. It then works toward the heart-wood, leaving a channel often one-half inch in diameter and six or more inches in length. The writer has observed one larva about an inch in length busily engaged in boring its way into the main trunk of a silver-maple about four inches in diameter a few inches above ground. The work was apparently just begun, for the cavity was shallow, and the body of the larva protruded from the new cavity half its length.

It requires two years for the insect to complete its life cycle. At the end of the first season the larva is half-grown and has made its way to one of the larger branches. The caterpillar remains in a dormant state during the first winter and resumes feeding the next spring, and toward the end of the second summer attains its full size. The second winter is passed in this condition and the next spring they form their pupae near the surface. The adult, which is a large white moth with black spots, emerges in the early summer, being most abundant in late June or early July. The eggs are deposited either singly or in masses in the crevices of the bark, each adult depositing five hundred to one thousand.

Plants Attacked by the Insect.

It is claimed by some that this insect attacks practically all deciduous shade-trees and many shrubs. A careful study of this insect in the New York Botanical Garden during the past season has shown it to be present on various trees and some shrubs, but some trees have thus far seemed to be free from the pest. The following account may be given of the plants attacked and the amount of damage resulting from this insect in our grounds:

Unsightly scars resulting from the wounds made by the leopard-moth.

The trees most commonly attacked are the maples, especially the silver-maple and the sugar-maple. It is difficult to find a maple which does not, or has not, harbored one or more of these borers. When entering the small branches the latter are weakened and often broken. If not broken, the bark originally covering the excavation made by the insect soon decays, leaving large holes in the sides of the branches, retarding their growth and often killing them thus disfiguring the tree. When the insect has entered the main trunk the attempts on the part of the tree to heal the wound results in the formation of large unsightly scars. These wounds are also the gateways for the entrance of other insects and fungi, and the wood is gradually decayed, weakening the tree and destroying its beauty. As the trees become older the insects restrict their attacks to the branches rather than the main trunk.

A large amount of damage has also been done to the ash-trees by this insect. It is difficult to find an ash-tree one to three inches in diameter in our grounds which has not been attacked by one or more of these borers and usually in their main trunks. One or two of these borers in the main trunk of a two-inch tree will so weaken and disfigure it that the tree is worthless. Probably more damage has been done to the young recently planted ash-trees in the Garden than to any other tree, doubtless due in part to the fact that more individuals of this tree are planted than of the other favorite hosts of this insect.

The box-elder is also a favorite host for this insect and damages to this tree are similar to those of the maples. This is probably of minor importance, since the box-elder is not so commonly planted.

A few sepcimens were also obtained from cultivated shrubs, *Spiraea* sp. and *Viburnum opulus*.

The basswood is also subject to considerable injury. A number of large larvae have been removed from the main trunks of basswood trees planted in conspicuous places in our grounds, although on the whole this tree does not seem to be attacked to the same extent as the ash and maple.

Several specimens were also obtained from the main trunks and smaller branches of the pin oak.

In various places this moth has been reported as doing great damage to the elm. Although there is some evidence outside of the Garden that the elms are attacked, so far not a single elm has been found to contain this borer within our grounds. Of course it has been impossible to examine the branches of the larger trees, and although it has not yet been found on our elms it is probable that the elm is also subject to the attacks of this insect.

It has been reported as attacking the tulip-tree, but none of our trees have thus far been found to be infected. The sycamore also seems thus far to be free from it.

Methods of Detecting its Presence.

During the early process of the boring the partly digested wood is thrown out of the opening made as the larva enters the tree and falls to the ground below. After the cavity becomes sufficiently large the opening is carefully closed by a whitish semitransparent web-like membrane. The opening through which the larva entered the tree being at this time completely covered, it is difficult to detect the point of attack except as guided by the droppings below. The wood around the wound however is usually darkened by the flow of sap, so that this will aid in locating the exact spot. The droppings are so characteristic that one can be reasonably certain of the presence of these insects by examining the ground underneath the tree. Guided by this the exact point of attack can also be located.

On one occasion the position of a large borer was located in the trunk of a young ash-tree and a small hole was cut to make sure of the presence of the insect. Having no means of removing the larva it was left until the following morning. At this time the same tree was visited and it was found that the larva had carefully recovered the hole made into its burrow. It was again opened and the larva—in this case about two inches in length—was removed.

The first step then in determining the presence of these insects is to carefully examine the ground under the tree for their characteristic droppings. It is then only the matter of a little time to locate the point at which the insect has entered the tree.

Basswood broken as a result of a wound caused by the leopard-moth.

Means of Control.

The "key-note" in the control of this pest is "eternal vigilance." As has already been mentioned, it is comparatively easy to detect the presence of this insect, but unfortunately it is not usually detected until the worst of its damage has been done. If, however, young and newly planted trees were closely inspected during the summer it is possible that many of these larvae could be detected before they have penetrated far into the tree. If the trunk of the tree could be protected the smaller branches could be pruned off when infected without ruining the entire tree. The destruction of the larvae even after the damage has been done to the tree would still be beneficial in preventing the spread of the insect, and this is no small item, since a single adult is able to lay a large number of eggs. In several cases during this season the larvae have been detected just as they were penetrating the bark, and destroyed. In such cases a double purpose is served, the destruction of the larva and the protection of the tree attacked.

There are two ways of destroying the larvae after they have entered the tree—(1) by injecting a poison such as bisulfid of carbon into the burrow and stoppping up the hole with putty and (2) by removing the larva with a wire provided with a hook or barb at the end. It is as easy to remove the larva as to kill it with poison, and this is probably the surest means of getting rid of it. The channels are nearly straight and so large that there is no difficulty in reaching them in this way.

The smaller infested branches on old trees should be removed and destroyed, and small trees which are badly infested in the main trunk should be replaced with healthy ones of the same kind, or as is still better, with those which are free from the attacks of this insect, if such trees can be found. The ash seems to be especially susceptible to this as well as to the ash-borer and it is doubtful if it should be planted to any great extent unless plans are made to guard it closely against these enemies.

Local control of this insect in parks ought to be easily effected, since it is claimed that the adult female cannot fly far, but is often blown from one tree to another. If this is the case local

inspection of trees and destruction of larvae should yield beneficial results.

Most strenuous means should be adopted for the detection and control of this insect in cities and parks, since it threatens the destruction of many of our most valuable shade-trees.

FRED J. SEAVER.

[Reprinted from TORREYA, Vol. 12, No. 11, November, 1912.]

ANCIENT AND MODERN VIEWS REGARDING THE RELATION OF TAXONOMY TO OTHER PHASES OF BOTANICAL WORK.—In the April number of TORREYA, Dr. P. A. Rydberg in his article on "Phytogeography and its Relation to Taxonomy and Other Branches of Science" says a few words in defense of taxonomic

work, as follows: "Not long ago all botanical work done in this country was taxonomic work, usually known as systematic botany, although much had indeed little of 'systematic' in it. Now it is different. Courses in taxonomy are almost excluded from the curriculum of many of our colleges and universities or if not excluded so little esteemed that students are discouraged from entering upon them. *The taxonomist whether a systematic botanist in the true sense or a phytographer, is looked upon by phytogeographers, ecologists, physiologists, cytologists, and morphologists as of a lower grade of stuff;—as if it took a less fine grain of brain to make a first class systematist than any other kind of -ist.*"

It might be of interest to taxonomists as well as to those who are inclined to look upon physiology or morphology as representing the modern idea of what botany is or ought to be, while those whom they choose to call "mere taxonomists" are relegated to the same category as "stamp collectors," to compare recent views as expressed by Dr. Rydberg with those of one of the leading English mycologists who worked more than half a century ago.

In a paper read before the Quekett Microscopical Club on February 23, 1877, Dr. M. C. Cooke gave expression to his views in the following words: "In all branches of Natural History there are workers of two kinds: those who investigate the structure, physiology, origin, and development of a few forms, and endeavour to comprehend the whole mystery of their existence, and relationship to other manifestations of vital force, and those who devote themselves almost entirely to the study of various forms in any one or more groups, their relationship to each other, and their systematic and orderly arrangement, their affinities and their differences and their geographical distribution. *It is not uncommon to find those of the first group, the biologists, or physiologists, claiming a higher position for themselves than they accord to students of the other class, and even sneering at them as mere species-makers, or compilers of catalogues.* This is not only unjust but untrue; both are equally useful and equally essential and should not be made the subject of comparison. The work of the former is a great help to the latter whilst without classification there could be no science."

From the above quotations it will be seen that the ideas of those who are inclined to draw unjust comparisons between "mere taxonomy" and other phases of botanical work are not modern; neither are they restricted to this country but were current in England fifty years ago.

F. J. Seaver

[Reprinted from Mycologia, Vol. V., No. 3, May, 1913.]

Maire's Remarks on Some Hypocreaceae

Under the title "Remarques sur quelques Hypocréacées"[3] R. Maire discusses a number of species belonging to the genera *Pyxidiophora, Peckiella, Hypomyces,* and *Nectriopsis,* the last being a new genus. In this paper a number of data are given which add to our knowledge of the North American Hypocreales.

In the "Hypocreales of North America"[4] the writer made *Hypomyces boletinus* Peck a synonym of *Hypomyces chrysospermus* (Bull.) Tul. with a note that the spores in the North American specimens examined were smaller than usually indicated for European specimens. On this difference Maire retains the American form as a variety of the European. At the time this note was made it was the opinion of the writer that the difference in size of the spores was due to immaturity of the plants examined. It still seems likely that this apparent difference would fade out if a careful comparison could be made of a sufficient number of plants from both America and Europe. The species is common on *Boletus* but the conidial phase is more common than the perfect and is identical in the European and

[3] Ann. Myc. 9: 315–326. 1911.
[4] Mycologia 2: 76. 1910.

American plants. The perithecia develop quite readily in the laboratory.

After a study of cotype material of *Hypomyces hyalinus* (Schw.) Tul. in the herbarium at Paris, Maire agrees with the writer in regard to the spore characters, the species being characterized by the unequally septate, verrucose spores. *Hypomyces inaequalis* Peck is used as a synonym as has been previously done by the writer (l. c.). Maire calls attention to the fact that the species has also been recorded from Europe, a fact which was overlooked in our own monograph.[5]

Hypomyces macrosporus Seaver is made a synonym of *Hypomyces armeniacus* Tul. When this species was described a note was appended stating that the plant was first thought to be *Hypomyces ochraceus* (Pers.) Tul. The absence of material illustrating this species in Persoon's herbarium, together with several apparent differences, led me to describe the species as new. Maire points out that it is identical with *Hypomyces armeniacus* Tul. in the Paris herbarium and adds *Hypomyces ochraceus* (Pers.) Tul. as a doubtful synonym. These observations are important as they clear up the identity of our North American species. The species is characterized by the very large verrucose spores.

Specimens of *Hypomyces tegillum* Berk. & Curt. in the herbarium at Kew show perithecia, but no mature asci were seen. Maire reports that cotype material in the Paris herbarium have asci in good condition, and completes the description of the species. *Hypomyces papyraceus* (Ellis & Holw.) Seaver differs in the much smaller spores.

Nectriopsis is proposed as a new genus, differing from *Byssonectria* in its 2-celled spores. *Hypomyces violaceus* Tul., which was placed in the genus *Byssonectria* by the writer, is included in the new genus. *Hypomyces aureo-nitens* Tul. is also included in the new genus. The American material described under this name in NORTH AMERICAN FLORA is said to differ in its much smaller spores and the absence of the *Penicillium*-type of conidia.

The paper is illustrated with one plate containing careful drawings of the spores of the species discussed, and is a valuable addition to our knowledge of the North American Hypocreales.

F. J. SEAVER.

[5] Fries, Summa Veg. Scand. 383. 1849.

NO 29

[Reprinted from MYCOLOGIA, Vol. V., No. 3, May, 1913.]

WOLLENWEBER'S STUDIES ON THE FUSARIUM PROBLEM

A paper entitled "Studies on the Fusarium Problem," by Dr. H. W. Wollenweber, appears in *Phytopathology* (3: 24–50. 1913). As an introduction to this paper he first discusses "unreliability of the stroma as a taxonomic character" in the ascomycetes. He says in referring to the stroma, "Doubts, however, as to the value of the basis of Fries' system have been frequently expressed." "These doubts have recently been confirmed by careful comparative studies of exsiccati and by pure culture study of ascomycetes and fungi imperfecti." He also says, "This system somewhat modified is still in use." Also, that it will be difficult or almost impossible to follow the proposition to divide the Hypocreales into groups according to the presence or absence of stroma as has been done in NORTH AMERICAN FLORA.

He might have discussed "Unreliability of Any Taxonomic Character" and all of the arguments which have been advanced in support of his ground would apply with equal validity to many if not all of these characters. That the stroma, in certain cases, is variable, has long been recognized by taxonomists, but to argue that divisions should not be made on this character because it is variable *in certain cases* is about as logical as to argue that the animal and plant kingdoms should not be separated because there are certain groups on the border line which at different stages in their life cycle partake of the character of both animal and plant.

If he had said that it is impossible to separate *some* Hypocreales on the presence or absence of stroma, his statement would be more nearly in accord with fact, but to say that the order as a whole cannot be separated on this character is misleading. Before one undertakes to judge as to the value of a character from a taxonomic point of view, he should first take the trouble to look up some of the facts involved. That Dr. Wollenweber did not do this is evident from his own writing, for in referring to the stroma he says, "It may, however, be of taxonomic value in extreme cases when it entirely encloses the perithecia . . . (*Claviceps, Cordyceps, Xylaria*)." If he had had the facts clearly in mind, he would have known that in certain species of both *Xylaria* and *Cordyceps* the perithecia are not immersed but entirely superficial. Again he writes, "Intermediate groups such as the Hypo-

creaceae having free perithecia, or with the latter partly covered by the stroma. . . . " . . . In many of the Hypocreaceae, contrary to his statement, including the genus *Hypocrea* itself and related genera, the perithecia are entirely immersed, in fact are scarcely more than cavities hollowed out of the stroma. In no genus in the whole order is any character more constant and reliable than the stroma in *Hypocrea, Chromocrea, Chromocreopsis, Podostroma* and other related genera. Even in such cases as *Cordyceps,* in which it might appear extreme to one whose knowledge of the genus is limited to one or two species, the stroma is sometimes quite variable. In at least one case, *Cordyceps Cockerellii,* the stroma becomes so changeable and unreliable that it is on the border line between *Cordyceps* and *Ophionectria.* But, as a whole, the genus *Cordyceps* is well defined. If there were no intermediate forms, classification would be no problem.

Again, referring to Maire's work on *Nectriopsis,* he writes, "In pure culture [*Hypomyces*], however, I find apiculi or sharply pointed ends only on young ascospores, with more or less obtuse ends in maturity." The species on which this observation was made is not named. The genus *Hypomyces* was founded by Tulasne (not Plowright) on *Sphaeria Lactifluorum.* This species has been studied by the writer from living material both in the laboratory and field over long stretches of time, involving literally bushels of material and in no case have my observations on the ascospores borne out those of Wollenweber, which leads me to suspect that the peculiar condition observed in his work was due to abnormal conditions or possibly that he did not have a *Hypomyces* at all.

On this latter observation, which is so lacking in detail that it is not conclusive, he rules that the morphology of the ascospore is not a reliable character on which to separate *Hypomyces* and *Nectria.* On even more limited observation he adopts a new character, "true chlamydospores," in which, to use his own words, "we have an excellent differential character between both genera." What reason he has to assume that chlamydospores occur throughout the genus *Hypomyces* and not throughout the genus *Nectria,* since they have been reported in some species of both genera, he does not make clear. If they should later be

found to occur throughout both genera, we cannot understand how their presence or absence could be used as a differential character between the two. If later they should be found to be common to many of the pyrenomycetes, having been already reported in several, we fail to understand how their presence could be of any value as a generic character at all. Then, with our present incomplete knowledge of the nature of, or the conditions under which chlamydospores are formed, what reason have we to believe that they are constant in their occurrence in any given species? Is it not possible that their presence or absence may be even more unreliable than the stroma itself?

On the above outlined uncertain evidence, he adopts the presence or absence of chlamydospores as a differential character between *Nectria* and *Hypomyces* and proposes in order to make the character fit the few species investigated to transpose all the species of *Nectria* in which chlamydospores *have been reported* to the genus *Hypomyces,* and publishes the new combination for *Nectria Ipomoeae* Halsted.

While no line of work is of more value to the taxonomist than life history study of the various species of fungi, yet to attempt to draw general conclusions as to the value of taxonomic characters by an investigation of a few isolated species is not improving classification but only adding chaos to confusion. After thus so easily disposing of most of the difficulties in the classification of the Hypocreales, he then proceeds to record the results of his work on *Fusarium,* in which field he has contributed much valuable knowledge to the cause of science.

The genus *Fusarium* is divided into sections on the basis of the forms of the conidia, as follows: Elegans, Martiella, Discolor, Gibbosum, Roseum, and Ventricosum. The types of conida on which these sections are based are given in an accompanying plate. *Verticillium* is briefly considered, although showing no morphological relationship with *Fusarium. Ramularia,* which differs from *Fusarium* in its cylindrical conidia, is also considered.

It is assumed as a general rule that the presence of chlamydospores in certain sections of *Fusarium* indicates the absence of ascogenous stages. There are, however, exceptions in *Hypomyces* and *Nectria.*

The wilt disease is fully discussed. The view which has been previously advanced that *Neocosmospora* is an obligate saprophyte and not connected with *Fusarium vasinfectum* Atk., as has been supposed, is sustained. The question then arises as to the validity of the name *Neocosmospora vasinfecta* Smith, the species having been founded on Atkinson's name given to the *Fusarium*. This illustrates the difficulty, at the present stage of our knowledge, of relying on conidial characters in the classification of the Ascomycetes.

Considerable space is devoted to "Tuber rot and ring discoloration of the potato." According to his investigations, six species of *Fusarium* have been confused with *Fusarium Solani;* also *Hypomyces Solani* and *Nectria Solani,* which have been thought to represent its ascogenous stage and are now regarded as harmless saprophytes. It is claimed that all of these species of *Fusarium* can be distinguished on morphological characters.

This paper contains many valuable suggestions, but, from the standpoint of a taxonomist, it would seem to me that if more space had been used in recording exact details of pure culture experiments on which these conclusions are based and a little less in generalizing on their probable application, its value would have been greatly enhanced, at least so far as our knowledge of the ascomycetes is concerned.

F. J. SEAVER.

·/NO 30·

THE HICKORY BARK-BEETLE

FRED J. SEAVER

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14: 124–126. June, 1913.

[Reprinted from JOURNAL OF THE NEW YORK BOTANICAL GARDEN, June, 1913.]

THE HICKORY BARK-BEETLE

WITH PLATES CXVIII AND CXIX

For several years past the hickories have been dying at an alarming rate in the northern and eastern United States, and in fact almost throughout the range of the growth of these trees. The city parks, including the New York Botanical Garden, have suffered their share of the loss. While there may be a complication of causes it is usually agreed that the bark-beetle is responsible for a large part of this loss.

MEANS OF DETECTING ITS PRESENCE

One of the first evidences of the presence of this insect is the premature dying and falling off of the leaves of the trees in mid-summer, July and August. Frequent inquiries as to the cause of this premature defoliation of the hickories have been referred to the Garden during the past summer. The leaves may fall to the ground or may be only partially detached and remain hanging in a dead condition, greatly injuring the appearance of the tree. If the fallen leaves are closely examined it will be found that there is a small cavity at the base of the petiole which has been made by the adult beetle, which feeds upon the buds and soft tissues of the smaller branches of the tree. These cavities so weaken the petioles that the leaves are easily broken from the tree by the wind. If the insect would confine its attacks to the smaller branches, twigs and leaves the damage resulting from its work would be comparatively slight, but they also attack the large branches or main trunk and it is here that the principal part of the damage is done.

LIFE HISTORY AND HABITS

The adult beetles emerge in June or early July and feed upon the smaller branches or bore directly into the bark of the tree. Both the males and females enter the tree, the males for food and the females to deposit their eggs. In depositing her eggs the female confines herself to the main trunk or larger branches. The hole through which she enters is bored inward and upward.

Just under the bark an egg-gallery often an inch or more in length is worked out. The eggs are deposited on each side of this cavity and range in number from twenty to forty or fifty to each adult. The female usually dies after depositing her eggs and her remains can often be found in the old egg-gallery. The larvae, small white grubs, hatch in a short time and immediately begin to work their way outward between the bark and the wood, each larva making a separate burrow, which grows larger as they proceed outward on account of the increase in the size of the larvae. They remain in the burrows over winter and emerge in the adult form the following June or July, thus completing the life cycle.

They are often present in such large numbers that the entire bark is almost severed from the tree and the exit holes are so numerous that the large branches often appear to have been filled with buckshot.

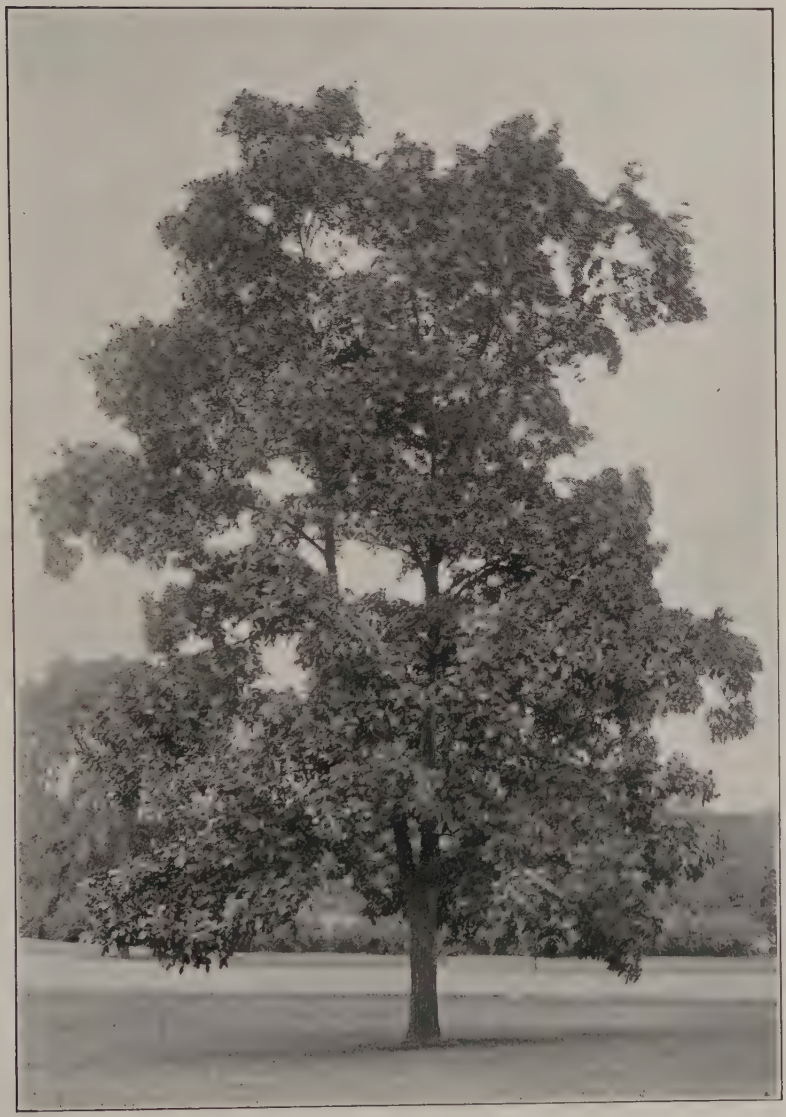
The work of this insect in the branches or main trunk of the tree results in a partial or entire girdling of the tree according to the number of insects present. This results in the dying of the part of the tree attacked. The trees are not usually killed outright but larger branches are often attacked and killed first, the work gradually spreading to the entire tree.

Local Observation

In the inspection of the hickories in the Garden it has been difficult to find many of the larger and older trees which are not thoroughly infested by this insect. Among the large number of younger trees ranging from three to five inches in diameter comparatively few appear to have been attacked in their main trunks in such a way as to accomplish much damage. In the few cases in which young trees have been attacked the insects often appear to have died without emerging. In the rare cases in which the young trees are attacked the adjacent tree is often entirely free from the insect. The reason for this is not evident.

Natural Enemies

Among the natural enemies of this insect are birds, especially woodpeckers and species of ichneumon-flies. As to just how



An isolated hickory tree (*Hicoria ovata*) in a normal and healthy condition as indicated by the absence of dead branches.

much influence woodpeckers may have in holding this particular insect in check it is difficult to say. We find abundant evidence that these birds do work on the infested branches, but possibly in quest for other insects than the bark-beetles. There seems to be no reason however to assume that they do not feed on these beetles, since they can be easily reached in the summer when feeding the soft tissues of the tree and also when boring into the bark. The ichneumon-flies are said to parasitize the bark-beetles by depositing their eggs within the body of the insect, thus killing them before they have had a chance to emerge.

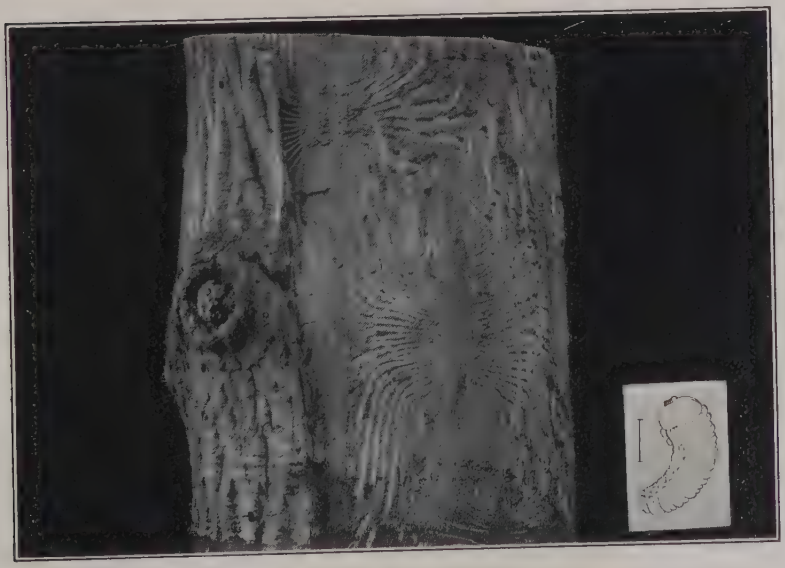
Artificial Means of Control

The means recommended by the Department of Agriculture for controlling this insect is the cutting down and destroying of all infested trees or parts of trees in order to reduce the number of insects. This must be done between October and May to catch the insects before they emerge.

The dead or dying hickories should be marked during the summer and fall in order to determine which trees are dead or partially dead. These may then be cut down during the winter and early spring. The infested trees or branches should be treated in such a way as to destroy the grubs present in or just under the bark. This may be done by removing the dark and burning it or by using the wood and bark for fuel. Spraying is not recommended for this insect.

Fred J. Seaver.

Branch from a hickory infested with bark-beetles showing exit holes and beetle. Beetle enlarged ; branch reduced nearly one half.



Infested branch with bark partially removed, showing galleries made by the adults and burrows made by the borer or larval stage of the beetle. Larva enlarged ; branch reduced nearly one half.

No 51

SOME TROPICAL CUP-FUNGI

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. V, No. 4, July, 1913

COOKEINA SULCIPES (Berk.) O. Kuntze
COOKEINA TRICHOLOMA (Mont.) O. Kuntze

[Reprinted from Mycologia, Vol. V., No. 4, July, 1913.]

SOME TROPICAL CUP-FUNGI

Fred J. Seaver

(With Plates 88–90)

The genus *Cookeina* was established by O. Kuntze to take the place of *Trichoscypha* of Saccardo, the latter name being untenable. A month later the genus *Pilocratera* was proposed by P. Hennings for the same reason, apparently without knowledge of Kuntze's work. The name *Pilocratera* was adopted by Lindau in Engler & Prantl's Natürlichen Pflanzenfamilien, but incorrectly so since the name proposed by Kuntze had priority. The genus is most closely allied to *Sarcoscypha* of Saccardo, but the species which are essentially tropical are probably distinct enough to be retained in a separate genus.

As the name implies, the plants are usually hairy and the hairs when present are composed of a fascicle of mycelial threads the whole tapering into a bristle-like apex. In one species, *C. Colensoi,* which is here included with the genus, the hairs are absent and the outside of the cup is clothed with granules consisting of loosely arranged cells. While well-developed hairs are wanting in this species other characters indicate a close relationship with the other members of the genus to which it undoubtedly belongs.

Another character of the genus which deserves especial mention is the peculiar markings of the spores. Three of the four species examined have striate spores. In one species, *C. insititia,* no striations were observed. However, as only one collection of this species has been seen it is possible that a further study of the species will reveal this character. The striations are not in

the nature of thickenings or cracks such as those found in some of the Ascobolaceae but are light and dark bands extending from one end of the spore to the other but not roughening its surface, at least so far as can be determined. The width of the bands varies in different species. This character seems to be more common in tropical ascomycetes than in temperate and northern species, having also been observed by the writer in several of the tropical Hypocreales. It has also been mentioned by Doctor Thaxter in the genus *Wynnea* which genus is tropical although one species runs up into the northern United States. There may be no significance in this coincidence but it is sufficiently striking to deserve mention. All of the species examined in the present genus have either fasciculate hairs or striate spores or both; all are bright colored, more or less stipitate, of a tough consistence, grow on wood and have a similar distribution.

The genus *Phillipsia* which is treated in this paper shows a very close relationship with *Cookeina*. One species of the genus has been frequently collected in the West Indies and until recently has been filed away in our collections as an unnamed species of *Sarcoscypha*. In fact the plants very closely resemble our *Sarcoscypha coccinea*. The color of the hymenium is darker being reddish-purple instead of scarlet and the spores are unequal-sided and marked with the striations referred to in connection with *Cookeina*. The great variability in the stem and other gross characters has doubtless led to the multiplication of synonyms in this species. The genus *Phillipsia* was based on specimens in which the stem was almost wanting and had the nature of the plant been fully appreciated it is possible that the species might have been included with the preceding genus. Berkeley in describing *Peziza domingensis,* type of the genus *Phillipsia,* says,—"Though not oblique, it seems to be nearest to such species as *P. onotica,* or perhaps the two pedunculate species which follow [*Peziza Hystrix* and *Peziza Hindsii*]." This is the only reference seen which bears upon the relationship of *Phillipsia* and *Cookeina*. The striation of the spores is a character common to both genera but one which has apparently been overlooked, for it is not usually mentioned in the descriptions of any of the species of either genus except *Peziza striispora* Ellis & Everhart, which is here included as a synonym of *Cookeina Tricholoma*.

These studies are based on material in the herbarium of the Garden including numerous specimens obtained by Garden collectors in the West Indies and Mexico. The collections in several cases are accompanied by colored sketches made in the field by Mrs. Norman Taylor. These sketches show the colors to be a much brighter red than is shown in the published illustrations of the various species which must have been made from dried material or by guess from the descriptions. The photographs are made from dried material which in some cases is partially revived by wetting. On account of the tough consistence of the plants of these two genera they do not shrink a great deal in drying and the photographs compare very favorably with the drawings made from fresh material so far as the form of the cups is concerned. While these photographs do not bring out the colors they show many details which it is impossible to show even in a colored sketch. Drawings are made with the aid of a camera lucida, all spores being drawn to a common scale.

COOKEINA O. Kuntze, Rev. Gen. Pl. 2: 849. 1891

Peziza § *Trichoscypha* Cooke, Mycogr. 252. 1879.
Trichoscypha Sacc. Syll. Fung. 8: 160. 1889. Not *Trichoscypha* Hooker. 1862.
Pilocratera P. Henn. in Engler, Bot. Jahr. 14: 363. 1891.

Plants stipitate or substipitate, bright-colored, some shade of red or yellow, hairy or pruinose; hairs when present fasciculate; substance tough, not shrinking much in drying; asci 8-spored; spores hyaline or subhyaline, ellipsoid to fusoid, usually striate, striations consisting of light and dark bands extending lengthwise of the spore; paraphyses present, filiform.

Type species, *Peziza Tricholoma* Mont.

KEY TO THE SPECIES

Cups clothed with well-developed hairs.
- Hairs long and conspicuous, covering the outside of the cup. — *C. Tricholoma.*
- Hairs short and inconspicuous, mostly near the margin of the cup.
  - Cups large, shallow; spores 27–33 × 14–18 μ. — *C. sulcipes.*
  - Cups small, deep; spores 40–50 × 10–12 μ. — *C. insititia.*

Cups pruinose but with no well-developed hairs. — *C. Colensoi.*

COOKEINA TRICHOLOMA (Mont.) O. Kuntze, Rev. Gen. Pl. **2**: 849. 1891

Peziza Tricholoma Mont. Ann. Sci. Nat. II. **2**: 77. 1834.
Peziza Hystrix Berk. Ann. Mag. Nat. Hist. II. **9**: 201. 1852.
Trichoscypha Tricholoma Sacc. Syll. Fung. **8**: 160. 1889.
Pilocratera Tricholoma P. Henn. in Engler, Bot. Jahr. **14**: 364. 1892.
Peziza striispora Ellis & Ev. Bull. Lab. Nat. Hist. State Univ. Iowa **4**: 69. 1896.
Sarcoscypha striispora Sacc. Syll. Fung. **14**: 754. 1899.

Plants stipitate, cup-shaped, with the margin slightly incurved, 1–1.5 cm. in diameter and about 1 cm. deep; stem often so short that the plants appear to be sessile or 2–3 cm. long and about 2 mm. thick, exterior of the cup as well as the stem entirely clothed with long hairs which are more numerous around the margin forming an incurved border, entire plant deep-red or nearly scarlet and a little paler outside, fading in dried plants to pale-orange; hairs often 2–3 mm. long and 100–175 μ in diameter at the base, gradually tapering toward the apex, whitish or pale-brown and composed of a dense fascicle of mycelial threads; asci cylindric, about 350–375 $\times$ 20 μ, abruptly extended below into a short appendage-like base; spores ellipsoid to fusoid, about 27–33 $\times$ 12–14 μ, hyaline or subhyaline with one or two large oil-drops and granular within, usually marked with delicate, longitudinal striations; paraphyses filiform, slender, slightly enlarged upwards.

On old wood and bark.

TYPE LOCALITY, Central America.

DISTRIBUTION: West Indies, Mexico, Central America, and Philippine Islands. Also reported from Australia and South America.

ILLUSTRATIONS: Ann. Sci. Nat. II. **2**: *pl. 4, f. 2;* Cooke, Mycogr. *pl. 51, f. 202;* Engler-Prantl, Nat. Pfl. 1^1: 195, *f. 155*, C-E.

Massee[1] states,—"The two species enumerated above [*Peziza sulcipes* and *Peziza Hindsii*] are synonyms of each other, and in turn both are synonymous with *Peziza tricholoma* Mont." There seems to be no doubt as to the identity of *Peziza sulcipes* and *Peziza Hindsii* but from our own studies based on material col-

[1] Jour. Linn. Soc. **31**: 507.

lected in the West Indies, *Peziza Tricholoma* Mont. appears to be distinct. The difference is shown in the accompanying photograph (plate 88).

One new synonym is here added to the list, *Peziza striispora* Ellis & Everhart. This species was described from material collected at Castillo, Nicaragua. The type could not be found in the Ellis Collection but the description, locality, etc, leave little chance for doubt as to its identity.

COOKEINA SULCIPES (Berk.) O. Kuntze, Rev. Gen. Pl. 2: 849. 1891

Peziza sulcipes Berk. in Hooker's London Jour. Bot. II. 1: 141. 1842.
Peziza Hindsii Berk. in Hooker's London Jour. Bot. II. 1: 456. 1842.
?Peziza Afzelii Fries, Nov. Acta Reg. Soc. Scient. Upsal. III. 1: 121. 1855.
Trichoscypha Hindsii Sacc. Syll. Fung. 8: 161. 1889.
Trichoscypha sulcipes Sacc. Syll. Fung. 8: 161. 1889.
?Trichoscypha Afzelii Sacc. Syll. Fung. 8: 161. 1889.
Cookeina Hindsii O. Kuntze, Rev. Gen. Pl. 2: 849. 1891.
?Cookeina Afzelii O. Kuntze, Rev. Gen. Pl. 2: 849. 1891.
?Pilocratera Engleriana P. Henn. in Engler, Bot. Jahr. 14: 363. 1892.
Pilocratera Hindsii Lindau, in Engler-Prantl, Nat. Pfl. 1: 195. 1897.
Geopyxis elata Massee, Bull. Royal Gardens, Kew 1898: 123. 1898.

Plants stipitate, cup-shaped, 1–2 cm. in diameter and about 1 cm. deep or sometimes more shallow, exterior of the cup often marked with several concentric rings near the margin and fringed with very short hairs which are more numerous at or near the margin of the cup, hymenium deep-orange to nearly scarlet, externally paler, fading to pale-yellow in dried specimens; stem often so short that the cups appear to be sessile but occasionally as long as 3 cm. and about 2 mm. thick; hairs comparatively short, subconical in form, about 400–500 μ long and 75–100 μ broad at the base gradually tapering toward the apex, composed of a dense

fascicle of mycelial threads, pale yellow; asci cylindric, about 300–350 × 20 μ with a short appendage-like stem; spores ellipsoid with the ends slightly narrowed, hyaline or subhyaline with one or two large oil-drops and granular within, 27–33 × 14–18 μ, longitudinally marked with delicate striations; paraphyses filiform, slightly enlarged above.

On old wood and bark.

TYPE LOCALITY, Surinam, South America.

DISTRIBUTION: West Indies, Mexico to South America. Also reported from Australia.

ILLUSTRATIONS: Hooker's London Jour. Bot. II. **1**: *pl. 15* (in part); Cooke, Mycogr. *pl. 51, f. 199, 200;* Cooke, Australian Fungi, *f. 153;* Engler-Prantl, Nat. Pfl. **1**[1]: 195, *f. 155, F, G;* Engler, Bot. Jahr. **14**: *pl. 6, f. 9.*

One new synonym is added to the list above, *Geopyxis elata* Massee. I have examined the type of this species and find it identical in every respect with *Peziza sulcipes* Berk. While the type of *Pilocratera Engleriana* P. Henn. has not been seen, the description fits this species very closely and it is probably the same. In describing this species Hennings emphasizes the presence of the stripes about the outer margin of the cups which is characteristic of *C. sulcipes.*

COOKEINA INSITITIA (Berk. & Curt.) O. Kuntze, Rev. Gen. Pl. **2**: 849. 1891

Peziza insititia Berk. & Curt.; Berk. & Br. Jour. Linn. Soc. **14**: 103. 1875.

Trichoscypha insititia Sacc. Syll. Fung. **8**: 161. 1889.

Plants deep cup-shaped, stipitate, cup about 5–7 mm. in diameter and of about the same depth, yellow when dry (probably much brighter when fresh), clothed about the margin with rather numerous fasciculate hairs; hairs very broad at the base, often nearly 400–500 μ and 1–2 mm. in length; stem slender, 1–2 mm. in diameter and of variable length but often attaining 1 cm.; asci cylindric, very long, often 500 × 15–18 μ; spores 1-seriate or with the ends overlapping, fusiform, filled with oil-drops and granules, curved or unequal-sided, 40–50 × 10–12 μ, subhyaline; paraphyses filiform, slightly enlarged above.

On wood.

COOKEINA COLENSOI (Berk.) Seaver
COOKEINA INSITITIA (Berk. & Curt.) O. Kuntze
PHILLIPSIA DOMINGENSIS Berk.

TYPE LOCALITY: Peradeniya, Ceylon.

DISTRIBUTION: Philippine Islands, Ceylon, and Bonin Islands,

ILLUSTRATIONS: Cooke, Mycogr. *pl. 51, f. 201;* Jour. Linn. Soc. **31**: pl. 16, f. 26.

This species has not been found in the West Indies so far as known but it is not unlikely that it will be found to occur there. It is closely related to the other members of the genus but can be distinguished by the form of the cups and by differences in the spores.

Cookeina Colensoi (Berk.)

Peziza Colensoi Berk. in Hooker's Fl. New Zealand **2**: 200. 1855.
Peziza aluticolor Berk. Proc. Linn. Soc. **13**: 176. 1873.
Sarcoscypha Colensoi Sacc. Syll. Fung. **8**: 157. 1889.
Geopyxis aluticolor Sacc. Syll. Fung. **8**: 64. 1889.

Plants stipitate or substipitate, shallow cup-shaped, 1–1.5 cm. in diameter and about 5 mm. deep, dried plants pale-yellow (probably much brighter when fresh) marked with concentric rings about the outer margin, externally covered with loose cells which sometimes approach rudimentary hairs but with no well-developed hairs, wrinkled when dry especially near the base of the cup; stem very short or almost wanting, sometimes not more than 1 mm. in length, never long as in related species; asci cylindric, about 400–475 × 20 μ, gradually tapering below; spores 1-seriate or with the ends slightly overlapping, fusoid with the ends quite strongly narrowed, with one or two large oil-drops and granular within, striations consisting of several broad, longitudinal bands extending the length of the spore, 30–40 × 12–15 μ; paraphyses filiform, scarcely enlarged above.

On wood and bark.

TYPE LOCALITY: New Zealand.

DISTRIBUTION: West Indies, New Zealand, Australia, and Africa.

ILLUSTRATIONS: Hooker's Fl. New Zealand **2**: *pl. 105, f. 5;* Cooke, Mycogr. *pl. 50, f. 198.*

The plants of this species examined are almost sessile although the species is often described and illustrated with a stem several mm. long. The stem is probably variable as in other species of the genus although it has never been found to attain the length characteristic of other species of the genus. With the exception

of the shorter stem, and absence of hairs the cups of this species might easily be mistaken for a subsessile form of *Cookeina sulcipes*. The spores however are quite different. *Geopyxis Möldcriana* P. Henn.[2] does not seem to differ materially from this species so far as can be judged from the published description.

PHILLIPSIA Berk. Jour. Linn. Soc. **18**: 388. 1881

Plants attached to the substratum by a very broad base which is often extended into a rather long, thick stem, hymenium bright-colored; substance tough, not shrinking much in drying; asci 8-spored; spores usually striate, subhyaline; paraphyses present, very slender.

TYPE SPECIES, *Peziza domingensis* Berk.

PHILLIPSIA DOMINGENSIS Berk.

Peziza domingensis Berk. Ann. Mag. Nat. Hist. II. **9**: 201. 1852.
Peziza crispata Berk. & Br. Jour. Linn. Soc. **10**: 367. 1869.
Helotium purpuratum Kalchbr. in de Thümen, Myc. univ. 1614. 1880.
?Peziza Harmoge Berk. & Br. Jour. Linn. Soc. **14**: 104. 1875.
Phillipsia kermesina Kalchbr. & Cooke, Grevillea **9**: 25. 1880.
Phillipsia subpurpurea Berk. & Br. Jour. Linn. Soc. **14**: 104. 1875.
Lachnea crispata Sacc. Syll. Fung. **8**: 682. 1889.
Otidea domingensis Sacc. Syll. Fung. **8**: 97. 1889.

Plants shallow cup-shaped, regular or occasionally unequal-sided, attached by a broad base, sometimes nearly as broad as the cup, base often extended into a thickened stem 1 cm. long, hymenium dark reddish-purple, externally much paler, nearly white or with a pinkish tinge or fading to a dirty-yellow in dried plants, more or less downy especially near the base; substance tough and corky in dried plants, hymenium becoming pitted as a result of unequal shrinkage in drying, often giving it the appearance of a resupinate polypore; asci cylindric, about 300–360 × 15–20 μ, gradually tapering below into a long stem-like base; spores 1-seriate or with the ends slightly overlapping, ellipsoid, ends very blunt or more rarely abruptly narrowed, unequal-sided, striated, striations consisting of a few broad bands extending the length

[2] Hedwigia **41**: 30. 1902.

1, 2. COOKEINA TRICHOLOMA (Mont.) O. Kuntze; 3–5. COOKEINA SULCIPES (Berk.) O. Kuntze; 6. COOKEINA INSITITIA (Berk. & Curt.) O. Kuntze; 7. PHILLIPSIA DOMINGENSIS Berk.; 8. COOKEINA COLENSOI (Berk.) Seaver

of the spore, with one or two large oil-drops and often several smaller ones, subhyaline; paraphyses filiform, slightly enlarged at their apices.

On old wood and bark.

TYPE LOCALITY: Santo Domingo.

DISTRIBUTION: West Indies, Australia, and Africa.

ILLUSTRATIONS: Cooke, Australian Fungi, *pl. 191, f. 151;* Grevillea 9: *pl. 136, f. 21;* Jour. Linn. Soc. 31: *pl. 16, f. 7, 8 and 9.*

The above are some of the synonyms of this species, which have probably resulted from the great variability of the plants. It is not unlikely that further study of tropical discomycetes will add still other synonyms to the list.

EXPLANATION OF PLATES

PLATE LXXXVIII

Cookeina sulcipes (Berk.) O. Kuntze (upper figure).
Cookeina Tricholoma (Mont.) O. Kuntze (lower figure).

PLATE LXXXIX

Cookeina Colensoi (Berk.) Seaver (upper figure).
Cookeina insititia (Berk. & Curt.) O. Kuntze (middle figure).
Phillipsia domiggensis Berk. (lower figure).

PLATE XC

1. *Cookeina Tricholoma;* ascus, spores and paraphyses.
2. *Cookeina Tricholoma;* hair from outside of cup.
3. *Cookeina sulcipes;* ascus, spores and paraphyses.
4 and 5. *Cookeina sulcipes;* hairs from outside of cup.
6. *Cookeina insititia;* ascus and spores.
7. *Phillipsia domingensis;* ascus and spores.
8. *Cookeina Colensoi;* ascus and spores.

NEW YORK BOTANICAL GARDEN.

No 32.

THE GENUS PSEUDOPLECTANIA

J. F. Seaver

Reprinted from Mycologia, Vol. V, No. 6, November, 1913

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THE GENUS PSEUDOPLECTANIA

F. J. SEAVER

(With PLATES 109 AND 110)

The genus *Pseudoplectania* was founded by Fuckel and originally included the two species, *P. nigrella* and *P. fulgens*. The latter species was later removed from the genus by Saccardo and made the type of a new genus *Otidella*. Two additional species, *P. melania* and *P. stygia*, were, however, added to the genus at this time. One of these, *P. stygia*, is probably a synonym of the older species, *P. nigrella*. If we retain *P. fulgens* in the genus, it then contains three valid species all of which are known from North America. The following is a synopsis of our present knowledge of the genus in North America.

PSEUDOPLECTANIA Fuckel, Symb. Myc. 324. 1869

Caloscypha Boud. Bull. Soc. Myc. Fr. 1: 103. 1885.
Otidella Sacc. Syll. Fung. 8: 99. 1889.
Melascypha Boud. Hist. Class. Discom. Eu. 56. 1907.

Plants gregarious or scattered, sessile or stipitate, large, fleshy, externally clothed with short, slender, flexuous and often coiled or twisted hairs, sometimes giving to the exterior of the cup a tomentose appearance; asci cylindric-clavate, 8-spored; spores perfectly globose, smooth, hyaline; paraphyses straight or curved.

Type species, *Peziza nigrella* Pers.

KEY TO THE SPECIES

Plants entirely black or brownish black.
  Plants long-stipitate, sparingly clothed with straight or slightly flexuous hairs. *P. vogesiaca.*
  Plants short-stipitate or sessile and densely clothed with coiled hairs. *P. nigrella.*
Plants orange or occasionally with a greenish tint about the outer margin. *P. fulgens.*

Pseudoplectania vogesiaca (Pers.)

?*Peziza fuscocana* Alb. & Schw. Conspect. Fung. 312. 1805.
Peziza vogesiaca Pers.; Moug. & Nest. Stirpes Crypt. 584. 1818.
Peziza melania Pers. Myc. Eu. 1: 239. 1822.
Peziza melaena Fries, Syst. Myc. 2: 60. 1822.
Peziza spongiosa Peck, Bot. Gaz. 5: 35. 1880.
Pseudoplectania melaena Sacc. Syll. Fung. 8: 165. 1889.
Pulparia spongiosa Sacc. Syll. Fung. 8: 612. 1889.
Melascypha melaena Boud. Hist. Class. Discom. Eu. 56. 1907.

Plants large, attaining a diameter of 2–3 cm., cup-shaped or occasionally nearly plane, margin more or less wavy, externally black and very sparingly clothed with short, brown, flexuous hairs, stipitate, hymenium dark olivaceous-brown; stem variable in length, often 2–3 cm. and about 3 mm. thick, rooting below by a dense mass of dark brown, coarse hairs, 5–7 μ in diameter, both stem and exterior of the cup often longitudinally wrinkled, giving rise to vein-like markings, the whole plant often resembling a gill fungus; asci cylindric with a very long stem-like base, entire ascus 200–275 $\times$ 16–18 μ; spores 1-seriate, globose with one large oil-drop, at first hyaline, becoming very pale brown, smooth; paraphyses slender, brown and coiled or hooked at their apices, about 3–4 μ in diameter.

On decaying wood among moss, especially *Sphagnum,* in coniferous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: Vermont to Minnesota; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 343;* Cooke, Mycogr. *pl. 49, f. 193;* Rabenh. Krypt. Fl. 1[3]: 1030, *f. 1.*

Cotype material of *Peziza spongiosa* Peck (*Pulparia spongiosa* Sacc.) has been examined and this agrees in every detail with cotype material of *Peziza vogesiaca* Pers. as shown in the accompanying plates. The only other American specimens of this species examined were collected by Macoun in British Columbia, June 4, 1889, and referred to *Peziza spongiosa* Peck. The species has been reported from Minnesota by Miss Daisy Hone[1] as *P. melaena* Fr. It has also been reported from Wisconsin by Dr. B. O. Dodge in a paper now in press.

[1] Minnesota Botanical Studies 4: 70. 1909.

Peziza fuscocana Alb. & Schw. is claimed to be the same, and, if so, the name has priority. No authentic material of this species has been seen.

PSEUDOPLECTANIA NIGRELLA (Pers.) Fuckel, Symb. Myc. 324. 1869

Peziza nigrella Pers. Syn. Fung. 648. 1801.
? *Peziza stygia* Berk. & Curt. Grevillea 3: 153. 1875.
Plectania nigrella Karst. Act. Soc. Fauna Fl. Fenn. 2: 119. 1885.
? *Pseudoplectania stygia* Sacc. Syll. Fung. 8: 166. 1889.
Otidella nigrella Schr. in Cohn Schles. Kryptfl. 3^2: 48. 1893.
Lachnea nigrella Gill. Discom. 78. (1874?)

Plants gregarious or occasionally closely crowded, sessile or substipitate, at first closed and subglobose, becoming expanded and cup-shaped or nearly plane, hymenium brownish-black, margin often wavy and slightly incurved, externally clothed with very fine hairs, 5 mm. to 1.5 cm. in diameter; hairs very long but usually closely coiled and twisted giving to the exterior of the cup a slightly tomentose appearance, of nearly uniform thickness throughout their entire length, sparingly septate and pale brown, 4–6 μ in diameter; asci cylindric or subcylindric with a long stem-like base, entire ascus often as long as 300–325 μ and about 15 μ in diameter at the thickest point; spores with a large oil-drop or often with several smaller ones, 12–14 μ in diameter; paraphyses enlarged at their apices and filled with brown coloring matter, about 4 μ thick.

On the ground in coniferous woods, among moss, especially *Sphagnum*.

TYPE LOCALITY: Europe.

DISTRIBUTION: New Jersey to Wisconsin, Alabama and Jamaica; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 344;* Cooke, Mycogr. *pl. 31, f. 120;* Gill. Discom. *pl. 65.*

Peziza stygia Berk. & Curt. differs only in its smaller size and longer stem. A fragment of the Carolina specimen has been examined and it seems doubtful if the species is distinct. Later collections may, however, prove it to be so.

PSEUDOPLECTANIA FULGENS (Pers.) Fuckel, Symb. Myc. 324. 1869

Peziza fulgens Pers. Myc. Eu. 1: 241. 1822.
Peziza cyanoderma deBary in Rabenh. Fungi Eur. 516. 1863.
Aleuria fulgens Gill. Champ. 41. 1879.
Otidella fulgens Sacc. Syll. Fung. 8: 99. 1889.
Barlaea fulgens Rehm in Rabenh. Krypt. Fl. 1^3: 930. 1896.
Calossypha fulgens Boud. Ic. Myc. 1908.

Plants cup-shaped, regular or irregular, often unequal sided, substipitate below and attached to the substratum by a dense mass of coarse mycelium which penetrates into the substratum and binds it together; cup 1–2 cm. broad and of about the same depth, hymenium orange, externally paler and usually with a greenish tinge especially about the margin, clothed with poorly developed golden-yellow hairs or hair-like structures; asci cylindric, gradually tapering below; spores 1-seriate, hyaline, smooth, 6–8 μ in diameter; paraphyses rather stout, filled with golden-yellow oil-drops.

On soil in coniferous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Wisconsin.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 319;* Cooke, Mycogr. *pl. 53, f. 209;* E. & P. Nat. Pfl. 1^1: 179, *f. 146, C, D.;* Gill. Champ. *pl. 38.*

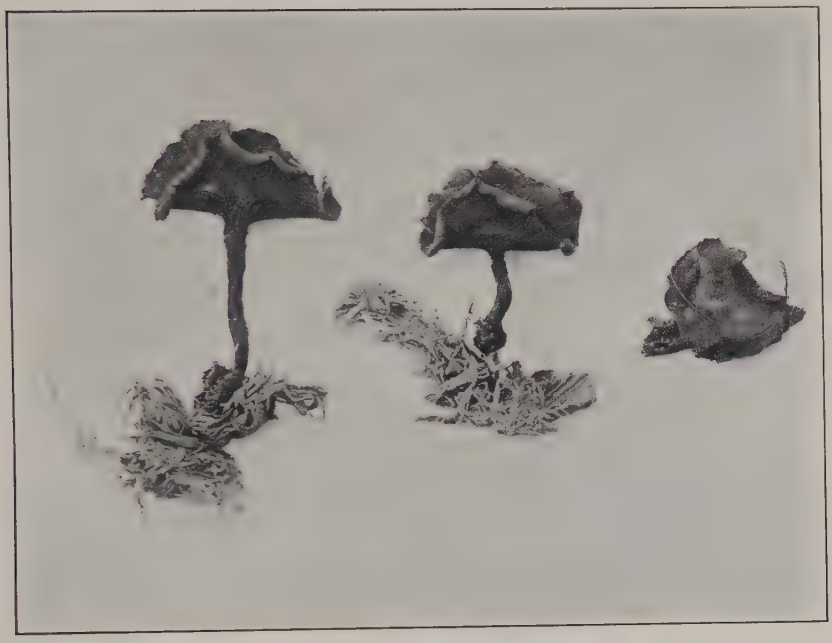
NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATES CIX AND CX

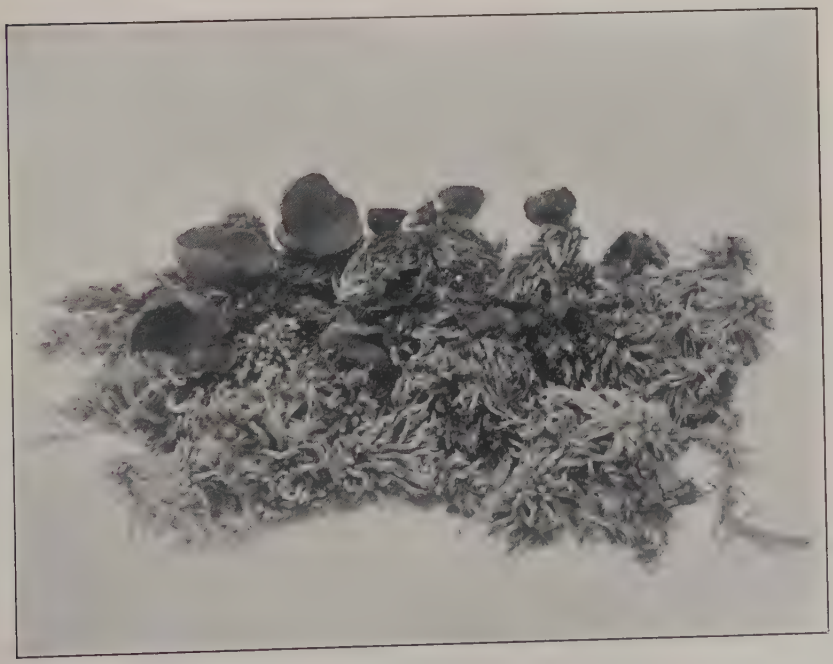
Plate 109 (upper figure). Cotype material of *Peziza spongiosa* Peck, which is identical with *Pseudoplectania vogesiaca* (Pers.) Seaver. Photographed in dried condition. Natural size.

Plate 109 (lower figure). *Pseudoplectania nigrella* (Pers.) Fuckel. Photographed from fresh specimens collected in a *Sphagnum* bog in New Jersey by Dr. B. O. Dodge. Natural size.

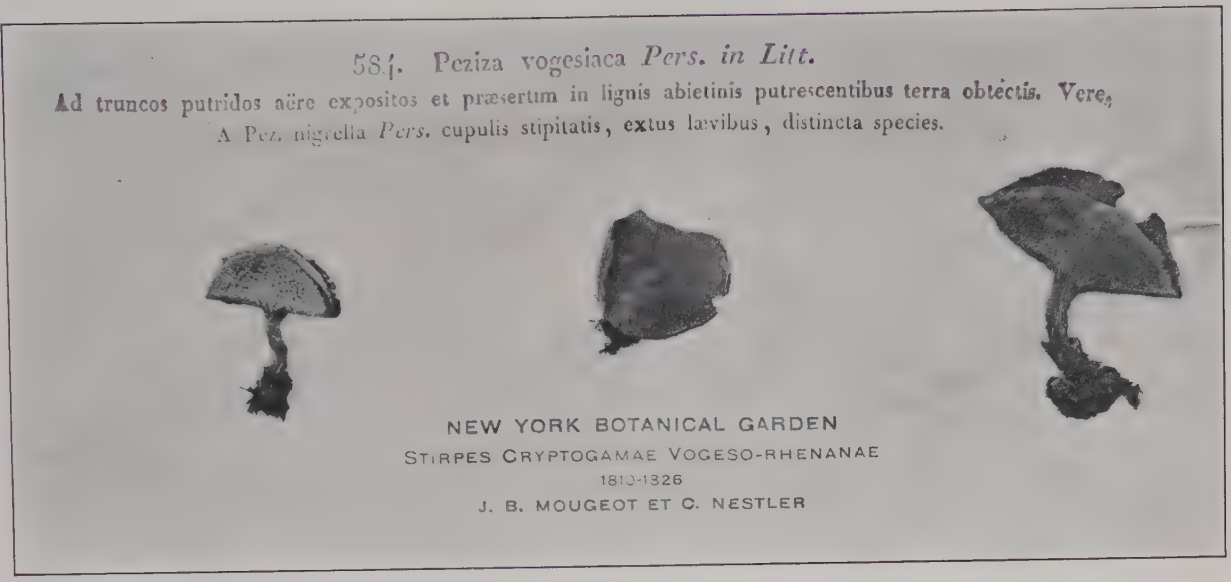
Plate 110. Cotype material of *Peziza vogesiaca* Pers., which was later described as the type variety of *Peziza melania* Pers. Photographed from herbarium specimen. Natural size.



PSEUDOPLECTANIA VOGESIACA (Pers.) Seaver



PSEUDOPLECTANIA NIGRELLA (Pers.) Fuckel


584. Peziza vogesiaca *Pers. in Litt.*
Ad truncos putridos aëre expositos et præsertim in lignis abietinis putrescentibus terra obtectis. Vere.
A Pez. nigrella *Pers.* cupulis stipitatis, extus lævibus, distincta species.
NEW YORK BOTANICAL GARDEN
STIRPES CRYPTOGAMAE VOGESO-RHENANAE
1810-1826
J. B. MOUGEOT ET C. NESTLER

Peziza vogesiaca Pers. (cotype)

No 33

A PRELIMINARY STUDY OF THE GENUS LAMPROSPORA

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. VI, No. 1, January, 1914

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A PRELIMINARY STUDY OF THE GENUS LAMPROSPORA

FRED J. SEAVER

(WITH PLATE 114, CONTAINING 13 FIGURES)

In a previous paper,[1] the writer has called attention to some of the difficulties in the study of the present genus and in the same paper described two new species. The accumulation of additional data regarding the various species of the genus together with the collection of several apparently undescribed species has led the writer to make a preliminary study of the genus in North America. One of the most conspicuous features of many of the plants of the genus is their small size, many of them being one millimeter or less in diameter. For this reason many of the species have apparently been overlooked and even the best known are not often collected. While the ground has been covered as thoroughly as possible at the present time, it is not likely that the following list contains nearly all of the species occurring in North America.

About half of the species of the genus have sculptured spores and the nature of the sculpturing in such species furnishes one of the most valuable diagnostic characters. In many of the old descriptions the spores were simply described as rough or smooth with no definite information as to the exact nature of these roughenings. In the present paper especial attention has been given to a study of these spore characters. In most cases these studies have been based on fresh material collected by the writer. In a few cases we have been compelled to rely on dried specimens. An attempt has been made to bring out these characters in the accompanying plate.

The genus as treated here is used in rather a broader sense than the genus *Barlaea* of Saccardo, being made to include the genus *Detonia*, which, so far as I am able to judge, differs only in

1 MYCOLOGIA 4: 45–48. 1912.

the larger size of the plants. The chief object of the present paper is to call attention to the number and variety of the species of the genus with the hope that these plants may receive more attention from collectors than they have formerly.

LAMPROSPORA De-Not. Comm. Critt. Ital. **1**: 388. 1864

Crouania Fuckel, Symb. Myc. 320. 1869. Not *Crouania* Agardh. 1842.

Plicaria Fuckel, Symb. Myc. 325. 1869.

Barlaea Sacc. Syll. Fung. **8**: 111. 1889. Not *Barlaea* Reich. 1877.

Detonia Sacc. Syll. Fung. **8**: 105. 1889.

Plicariella (Sacc.) Lindau in E. & P. Nat. Pfl. 1^1: 179. 1897.

Barlaeina Sacc. Syll. Fung. **14**: 30. 1899.

Pulvinula Boud. Hist. Class. Discom. 69. 1907.

Plants small or medium sized (.5 mm. to 3 cm. in diameter), concave, plane or slightly convex, sessile, usually bright colored, some shade of red, orange or yellow, more rarely pallid or dark colored, purple or brownish-black, externally smooth or verrucose but never clothed with well-developed hairs, substance fleshy, hymenium often roughened with the protruding asci; asci 8-spored, operculate; spores comparatively large, at first globose or subglobose, and smooth, at maturity often sculptured (spinulose, verrucose, reticulate, tuberculate or annulate), or remaining permanently smooth, hyaline or more rarely faintly colored yellowish or smoky-brown; paraphyses filiform or clavate, straight or curved.

Type species, *Ascobolus miniatus* Crouan.

KEY TO THE SPECIES

Plants small, not exceeding 5 mm. in diameter (usually 1 or 2 mm.).
Spores rough (reticulate, spinulose, verrucose, tuberculate, or annulate).
Spores marked with ridges.
Ridges giving rise to reticulations (net-like markings over the surface).
Reticulations shallow, barely roughening the surface of the spore.
Spores at maturity 20–22 μ in diameter, ridges of reticulations about 1 μ thick. 1. *L. Crouani.*

- Spores at maturity 12–15 μ in diameter, reticulations very delicate, scarcely more than lines over the surface of the spore. — 2. *L. dictydiola.*
- Reticulations deep, extending 2 μ or more beyond the periphery of the spore and appearing as a broad band about its surface. — 3. *L. areolata.*
- Ridges not giving rise to reticulations.
  - Ridges usually curved and extending in various directions as in some species of *Ascobolus*. — 4. *L. ascoboloides.*
  - Ridges giving rise to two distinct rings about the spore. — 5. *L. annulata.*
- Spores not marked with ridges.
  - Spores covered with spines.
    - Plants not exceeding 1 mm. in diameter, spines short, blunt. — 6. *L. spinulosa.*
    - Plants at maturity 3–5 mm. in diameter, spines long and very sharp. — 7. *L. Crec'hqueraultii.*
  - Spores covered with warts or tubercles.
    - Tubercles large, twelve or rarely fourteen or fifteen about the circumference of the spore.
      - Individual tubercles not rough. — 8. *L. tuberculata.*
      - Individual tubercles covered with minute roughenings, giving them a translucent appearance. — 9. *L. Maireana.*
    - Tubercles small, about twenty or more in the circumference of the spore.
      - Spores subglobose, on bark among moss. — 10. *L. Wrightii.*
      - Spores perfectly globose, on soil.
        - Plants pale orange. — 11. *L. tuberculatella.*
        - Plants violaceous. — 12. *L. amethystina.*

- Spores smooth.
  - Plants pale orange.
    - About 3 mm. in diameter at maturity, crowded, on burnt ground. — 13. *L. carbonaria.*
    - About 1 mm. or less in diameter, scattered, on damp soil. — 14. *L. haemastigma.*
  - Plants bright red.
    - Several mm. in diameter, spores 15–18 μ in diameter, on damp soil. — 15. *L. Constellatio.*
    - Less than 1 mm. in diameter, spores 8–9 μ in diameter, on foliage of *Sequoia*. — 16. *L. gemma.*
  - Plants pallid or creamy. — 17. *L. discoidea.*

Plants large, usually 5 mm. or more in diameter.
  Plants dark colored, purple or brown to blackish.
    Brown or blackish, occurring on burnt ground.
      Spores rough.
        Plants externally rough, spores about 18 μ in diameter. 18. *L. trachycarpa.*
        Plants externally smooth, spores about 9 μ in diameter. 19. *L. nigrans.*
      Spores smooth. 20. *L. leijocarpa.*
    Plants dark purple. 21. *L. Planchonis.*
  Plants bright colored, orange.
    Spores rough. 22. *L. lobata.*
    Spores smooth. 23. *L. polytrichina.*

1. **Lamprospora Crouani** (Cooke)

Ascobolus miniatus Crouan, Ann. Sci. Nat. IV. **10**: 197. 1858.
Not *A. miniatus* Preuss, Linnaea **24**: 147. 1851.
Ascobolus Crouani Cooke, Jour. Bot. **2**: 151. 1864.
Peziza Crouani Cooke, Grevillea **3**: 31. 1874.
Crouania miniata Fuckel, Symb. Myc. 320. 1869.
Lamprospora miniata De-Not. Comm. Critt. Ital. **1**: 388. 1864.
Aleuria Crouani Gill. Champ. Fr. Discom. 50. 1878.
Barlaea miniata Sacc. Syll. Fung. **8**: 111. 1889.

Plants gregarious, or crowded, at first subglobose, expanding and becoming plane or with the hymenium a little concave with a slightly elevated and often fringe-like margin, bright red, without and within, margin lighter, almost white, 1–5 mm. in diameter (usually about 3 mm. at maturity); asci cylindric or subcylindric, about 20–22 μ in diameter; spores 1-seriate, at first smooth and usually containing one large oil-drop, at maturity becoming delicovering the entire surface of the spore, meshes of the reticulacately roughened, roughenings taking the form of reticulations tions 2–4 μ, rarely 5 or 6 μ in diameter, ranging from 3–6-sided, with the sides usually of unequal length but occasionally giving rise to almost perfect hexagonal figures, ridges very even and delicate, less than 1 μ broad, the ridges giving rise to a perfect unbroken net-work about the spore and very shallow as indicated by the roughenings about the periphery of the spore, entire spore 15–22 μ in diameter (usually about 20–22 μ at maturity), hyaline; paraphyses thickened above and filled with orange granules.

On damp soil usually among moss plants.

TYPE LOCALITY: Brest, France.

DISTRIBUTION: New York to Colorado; also in Europe.

ILLUSTRATIONS: Ann. Sci. Nat. IV. 10: *pl. 13, f. 44–47;* Cooke, Mycogr. *pl. 5, f. 17;* Gill. Champ. Fr. Discom. *pl. 52, f. 2.*

Crouan's type has not been seen but authentic specimens from M. C. Cooke's collection have been examined and found to agree with American specimens referred to this species. One collection in great abundance was made near New York City during the past season.

2. LAMPROSPORA DICTYDIOLA Boud. Hist. Class. Discom. 68. 1907

Plants gregarious or scattered, not crowded, expanding with the hymenium, becoming plane or nearly so and bordered with a delicate, ragged, fringe-like margin and more or less pitted and roughened, entirely orange without and within, about 1 mm. in diameter (in the living specimens examined); asci cylindric or subcylindric, about 18–20 μ in diameter and of variable length; spores 1-seriate, at first smooth and usually with one large oil-drop, at maturity becoming very delicately reticulate, meshes of the reticulations 1 μ or less in diameter and ridges appearing as single lines (when examined with a one sixth objective); entire spore 12–15 μ in diameter, hyaline; paraphyses enlarged above reaching a diameter of 5 μ, nearly straight or occasionally a little curved, never hooked as in some related species.

On charcoal which has been overgrown with mosses.

TYPE LOCALITY: Montmorency, France.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATION: Boud. Ic. Myc. *pl. 403.*

Our specimens conform well with the illustration of this species by Boudier. The species has been collected twice but in each case not over two or three plants were found.

3. LAMPROSPORA AREOLATA Seaver, Mycologia 4: 48. 1912

Plants gregarious, small, .5–1 mm. in diameter, at first globose, opening rather irregularly, at maturity with the hymenium plane or slightly convex, more or less roughened by the protruding asci, orange to bright red; asci cylindric, 15–22 μ in diameter and of variable length, tapering below into a stem-like base; spores 1-seriate, at first smooth, with usually one large oil-drop, becoming rough at maturity, roughenings taking the form of deep areolations, areolae 3–5 μ in diameter, 3–6-sided, often forming

nearly perfect hexagonal figures or with the sides of irregular length, 2–3 μ deep as indicated by the projecting ridges about the periphery of the spore, ridges thin scarcely more than 1 μ thick, entire spore including projections 18–20 μ in diameter, hyaline; paraphyses strongly thickened above.

On damp soil among mosses and algae.

TYPE LOCALITY: Yonkers, New York.

DISTRIBUTION: New York to Connecticut.

ILLUSTRATIONS: Mycologia 4: *pl. 57, f. 5–8.*

Since the publication of this species, it has been frequently collected about New York City. The largest plants seen are not over 1 mm. in diameter. The peculiar spore characters mentioned in the original description have been found to be constant in all of the specimens examined.

4. **Lamprospora ascoboloides** sp. nov.

Plants gregarious, at first globose and partially buried, gradually opening with the hymenium at first slightly concave, gradually becoming plane and at maturity convex with the margin indistinct, usually not exceeding 1 mm. in diameter and often smaller, closely nestling in little depressions in the substratum but never buried, entirely orange, externally slightly floccose, hymenium roughened by the protruding asci which are comparatively large, finally becoming pitted as a result of the collapsing of the empty asci, the hymenium often collapsing when dry becoming concave; asci cylindric-clavate, about 175–225 × 18–20 μ; spores at first smooth with one or two oil-drops gradually becoming rough, increasing in size, at maturity covered with irregular ridge-like markings; ridges straight or more often curved, several often parallel or extending in various directions and sometimes at right angles, occasionally branched, rarely a few running together giving rise to irregular and imperfect reticulations over a part of the spore but never completely or perfectly reticulate, ridges nearly 2 μ thick, markings resembling those of certain species of *Ascobolus,* 15–18 μ in diameter (usually about 17 μ at maturity), hyaline; paraphyses clavate, 5–6 μ in diameter at their apices.

Type collected on soil in Portland, Connecticut.

DISTRIBUTION: Connecticut, New York and Virginia.

The species has been frequently collected about New York City since the original collection was made in Portland, Connecticut. The species is distinguished by the peculiar *Ascobolus*-like markings of the spores.

5. **Lamprospora annulata** sp. nov.

Plants gregarious but not crowded, at first globose and partially immersed in the substratum becoming expanded and with the hymenium plane or nearly plane and more or less pitted and roughened, pale orange, .5 mm. to nearly 1 mm. in diameter; asci cylindric or subcylindric, rather abruptly attenuated below into a short much contorted pedicel, entire ascus about 200 μ long and about 20 μ in diameter, at first almost filled with the spores, in older asci the lower part stretching and becoming about equal in length to the spore-bearing portion; spores 1-seriate from the first, perfectly globose and smooth when young and containing a few small oil-drops and granules, 12–14 μ in diameter, with two small rings appearing at an early stage about the proximal and distal sides of the spore giving rise to four small circles where the rings pass about the periphery of the spore, rings increasing in size until they reach a thickness of about 3 μ, the surface of the spore becoming minutely verrucose with age, the rings at maturity giving the spore a short cylindric appearance with the axis of the cylinder parallel with the ascus, entire spore when mature about 16–18 μ in diameter, rings of about the same diameter and nicely fitted over the opposite sides of the spore, the two rings usually parallel but occasionally one of them shifted out of its normal position, hyaline; paraphyses thickened above and densely filled with large granules, about 5 μ in diameter at the widest point.

On soil among moss and algae.

TYPE LOCALITY: Portland, Connecticut.

DISTRIBUTION: New York and Connecticut.

In addition to the type of this species which was collected in Portland, Connecticut, August, 1913, one collection was later made near New York City. This last collection consisted of three plants each less than one millimeter in diameter. The spore characters were identical with those of the Connecticut specimen.

6. **Lamprospora spinulosa** sp. nov.

Plants gregarious, minute, usually not exceeding 1 mm. in diameter and often less, at first closed and nearly globose, gradually expanding at maturity with the hymenium slightly convex and surrounded by an irregular fringe-like margin, externally slightly floccose, hymenium roughened by the asci which protrude

often half their length above the paraphyses, collapsing after discharging their spores; asci clavate-cylindric, about 200 × 18–20 μ; spores at first smooth with one large oil-drop, becoming delicately roughened, at maturity with short stout spines, about 1 μ in diameter and 2–3 μ in length, becoming adpressed when dry, entire spore about 15–20 μ in diameter (including spines), hyaline; paraphyses clavate, septate and granular within.

On soil among moss. New York Botanical Garden, 1912.

This plant which is 1 mm. or less in diameter has often been collected about New York City. The spores as well as the external characters of the species are very different from *L. Crec'hqueraultii* another spinulose-spored species. I find no description of the species.

7. LAMPROSPORA CREC'HQUERAULTII (Crouan) Boud. Ic. Myc. expl. pl. 11. 1909

Ascobolus Crec'hqueraultii Crouan, Ann. Sci. Nat. IV. **10**: 194. 1858.

Peziza modesta Karst. Act. Fauna Fl. Fenn. **10**: 122. 1869.

Peziza echinosperma Peck, Ann. Rep. N. Y. State Mus. **24**: 95. 1872.

Peziza auriflava Cooke, Mycogr. 16. 1875.

Aleuria auriflava Gill. Champ. Fr. Discom. 50. 1879.

Mollisia Crec'hqueraultii Gill. Champ. Fr. Discom. 118. 1882.

Crouania asperella Rehm, Hedwigia **24**: 226. 1885.

Humaria Crec'hqueraultii Quél. Enchir. 288. 1886.

Barlaea Crec'hqueraultii Sacc. Syll. Fung. **8**: 113. 1889.

Barlaea asperella Sacc. Syll. Fung. **8**: 113. 1889.

Barlaea modesta Sacc. Syll. Fung. **8**: 113. 1889.

Humaria echinosperma Sacc. Syll. Fung. **8**: 130. 1889.

Plicariella modesta Lindau in E. & P. Nat. Pfl. **1**²: 180. 1897.

Plants gregarious, 2–5 mm. in diameter (usually 2 or 3), entirely smooth without and within, hymenium at first slightly concave becoming plane or more often convex, margin indistinct in mature plants and entire plant often becoming irregular in form, very pale orange externally and internally, fading to dirty yellowish-white in dried specimens; asci cylindric, or subcylindric, about 300–325 × 27 μ protruding above the hymenium; spores 1-seriate, at first smooth, at maturity spinulose, globose, or rarely

very slightly elongated, spines conspicuous, irregular in length, broad at the base and tapering to a very sharp point at the apex, often 2 or 3 μ long, in dried specimens becoming bent and adpressed to the sides of the spore but regaining their normal form when wet, entire spore 18–22 μ in diameter (including spines), hyaline; paraphyses thickened at their apices.

On clayey soil.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Delaware, West Virginia and Colorado; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. **24**: *pl. 3, f. 10–13;* Ann. Sci. Nat. IV. **10**: *pl. 13, f. 12–15;* Boud. Ic. Myc. *pl. 404, 405;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 12, f. 4;* Cooke, Mycogr. *pl. 6, f. 22, 23.*

EXSICCATI: Ellis, N. Am. Fungi *840* (as *Peziza echinosperma* Peck); Ellis, N. Am. Fungi *841* (as *Peziza modesta* Karst.); Clements, Crypt. Form. Colo. *115* (as *Detonia modesta*).

In addition to the synonyms previously published, the writer has examined cotype specimen of *Peziza echinosperma* Peck and finds it to be identical with the above.

8. LAMPROSPORA TUBERCULATA Seaver, Mycologia **4**: 47. 1912

Plants gregarious in small clusters, not crowded but rarely with two or three in close contact, at first globose and almost buried in the sandy soil on which they grow, when young tapering above or subconic in form, with the hymenium gradually expanding and at maturity plane or nearly so, often with a fringe-like border and roughened by the protruding asci which appear above as minute white spines, superficial but with the base still nestling in the substratum, about .5 mm. in diameter or rarely attaining a diameter of nearly 1 mm.; asci cylindric or subcylindric, slightly narrowed near the apex, and tapering below into a stem-like base, 25–28 μ in diameter and about 275–300 μ long; spores 1-seriate, at first smooth and usually with one large oil-drop, gradually becoming rough, at maturity very coarsely tuberculate, tubercles covering the surface of the spore and appearing about its margin like great lumps often projecting further in one place than another giving the spore an irregular outline, individual tubercles about 3–4 μ in diameter, giving rise to 12 or rarely 14 or 15 lobes about the periphery of the spore, entire spore 18–20 μ in diameter at maturity, hyaline; paraphyses en-

larged above attaining a diameter of 6 μ, filled with orange granules.

On soil in open places among mosses and algae.

TYPE LOCALITY: Woods near Yonkers, New York.

DISTRIBUTION: New York to Virginia.

ILLUSTRATIONS: Mycologia 4: *pl. 57, f. 1–4.*

Numerous collections of this species have been made about New York City during the past season. The coarse tuberculate marking of the spores is a constant feature in all of the specimens examined.

9. **Lamprospora Maireana** sp. nov.

Plants gregarious, at first globose, becoming expanded, at maturity with the hymenium plane or slightly concave, entirely pale orange without and within, reaching a diameter of about 2 mm.; asci cylindric or subcylindric, gradually tapering below into a stem-like base, having a diameter of 30 μ at the broadest point and reaching a length of 300–325 μ; spores 1-seriate, perfectly globose, at first smooth, at maturity becoming roughened, roughenings taking the form of tubercles which are as large as 3–5 μ in diameter and appearing as scallops about the periphery of the spore, the tubercles bearing secondary roughenings which give to each a minutely roughened surface, and giving the whole spore a translucent effect, entire spore at maturity, about 23 μ in diameter, subhyaline; paraphyses strongly thickened at their apices, reaching a thickness of 8 μ.

On the ground among moss and algae.

TYPE LOCALITY: Algiers, North Africa.

DISTRIBUTION: New York; also in North Africa.

EXSICCATI: Maire, Myc. Bor. Africana *22* (as *L. tuberculata* Seaver).

This species was distributed by R. Maire as *L. tuberculata.* Close comparison however shows the two to be quite different. The plants are larger, the spores larger and the sculpturing of the spores quite different. The warts in the African species are not so prominent as in *L. tuberculata* and the secondary roughening of the tubercles does not occur in *L. tuberculata.* A single local collection has been made by the writer in which the spores agree with the specimen collected by Maire so that the species probably occurs in North America.

10. **Lamprospora Wrightii** (Berk. & Curt.)

Peziza Wrightii Berk. & Curt. Ann. Mag. Nat. Hist. III. **15**: 444. 1865.

Barlaea Wrightii Sacc. Syll. Fung. **8**: 112. 1889.

Humaria Wrightii Boud. Hist. Class. Discom. 68. 1907.

Plants gregarious or scattered, at first globose, becoming expanded with the hymenium plane or slightly concave, surrounded by a delicate irregular elevated margin giving it a fringe-like border, entirely pale orange, slightly paler externally and minutely roughened; asci cylindric or slightly clavate; spores usually 1-seriate or irregularly crowded, globose or more often just slightly ellipsoid, at first smooth, with one or sometimes several oil-drops, becoming roughened at maturity, roughenings taking the form of small wart-like bodies, which are usually rather widely scattered over the surface of the spore, 15–17 μ in diameter, hyaline; paraphyses strongly enlarged above, filled with granules.

On bark of trees among moss.

TYPE LOCALITY: Bodelwyddan, Flintshire, Wales.

DISTRIBUTION: Alabama, Texas and Cuba; also in Europe.

ILLUSTRATIONS: Ann. Mag. Nat. Hist. III. **15**: *pl. 15, f. 16;* Boud. Ic. Myc. *pl. 399;* Cooke, Mycogr. *pl. 5, f. 18.*

The spores were originally described as echinulate but this may have been due to faulty observation since later students of the type describe the spores as verrucose. An Alabama specimen examined agrees perfectly with Boudier's illustration of this species.

11. **Lamprospora tuberculatella** sp. nov.

Plants gregarious but never crowded, often five or six plants in the space of 1 cm., at first globose, opening at the top and gradually expanding, at maturity discoid, convex above and floccose with the asci which protrude above the hymenium half their length appearing as many minute white spines, whole plant pale orange, .3–.5 mm. in diameter or rarely reaching a diameter of 1 mm.; asci cylindric or subcylindric; spores 1-seriate, at first smooth and with one large oil-drop near the center, increasing in size as they mature, at maturity about 20 μ in diameter and covered with small tubercle-like markings, tubercles covering the surface of the spore and appearing beyond the periphery of the

spore like those of *L. tuberculata* but much smaller, about twenty to twenty-five around the circumference of the spore, hyaline; paraphyses enlarged above and filled with orange granules.

On soil among moss near Yonkers, New York.

This species has been frequently collected and much attention has been given to a study of the spore characters. As might at first be thought, the small wart-like markings have never been found to intergrade with those of *L. tuberculata* in which they are twice as large.

12. **Lamprospora amethystina** (Quél.)

Humaria Personii amethystina Quel. Fr. Acad. Sci. **14**: 451. 1885.

Barlaea amethystina Sacc. Syll. Fung. **8**: 116. 1889.

Plants gregarious, purplish, without and within, with a delicate white border, hymenium a little concave, reaching a diameter of 2 mm.; asci cylindric or subcylindric; spores 1-seriate, at first smooth, becoming rough at maturity, spore markings similar to those of *L. tuberculatella*, hyaline; paraphyses a little enlarged at their apices.

On the ground among moss.

TYPE LOCALITY: Jura, France.

DISTRIBUTION: Iowa; also in Europe.

ILLUSTRATIONS: Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 12, f. 3.*

The only specimens of this species seen were those collected by the writer in Iowa. The species is distinguished by its color.

13. **Lamprospora carbonaria** (Fuckel)

Crouania carbonaria Fuckel, Symb. Myc. (Nachtrag) 64. 1871.

Peziza sanguinaria Cooke, Grevillea **3**: 31. 1874.

Barlaea carbonaria Sacc. Syll. Fung. **8**: 112. 1889.

?Lamprospora carbonicola Boud. Hist. Class. Discom. 68. 1907.

Plants gregarious or crowded, 1–3 mm. in diameter, globose, becoming expanded with the hymenium plane or slightly concave and margin even or wavy, plants often irregular in form from mutual pressure, entirely pale orange, hymenium nearly even or

slightly floccose; asci cylindric-clavate, about 225 × 18–20 μ; spores perfectly globose and smooth with one oil-drop varying in size but often almost filling the spore, entire spore 15–18 μ in diameter, hyaline; paraphyses filiform or slightly enlarged at their apices, extending high above the asci and curved or hooked, about 3–4 μ in diameter at their apices.

On soil among moss plants in a place which has been recently burned but subsequently partially overgrown with moss.

TYPE LOCALITY: Oestrich and Budenheim woods, Germany.

DISTRIBUTION: New York; also in Europe.

Through the courtesy of Dr. Farlow, I have been permitted to examine spores of cotype material of this species. Specimens collected in the New York Botanical Garden agree with Fuckel's plants so far as we can judge from dried specimens. The species has been seen by the writer only once but occurred in good quantity.

14. **Lamprospora haemastigma** (Hedw.)?

Octospora haemastigma Hedw. Laub-Moose 2: 17. 1788.
Pulvinula haemastigma Boud. Hist. Class. Discom. 70. 1907.

Plants rather thickly gregarious, rarely two or three in close contact, at first globose, becoming expanded with the hymenium plane or slightly concave, entirely pale yellow (becoming brighter in dried specimens), about 1 mm. in diameter; asci cylindric or subcylindric, 20–23 μ in diameter and as long as 300 μ; tapering below into a stem-like base; spores 1-seriate, smooth, usually with one large oil-drop, about 20 μ in diameter, hyaline; paraphyses very slender, strongly curved at their apices and scarcely thickened above, about 2 μ in diameter at the thickest point, densely filled with yellow granules.

On damp soil among moss.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Hedw. Laub-Moose 2: *pl. 5, f. 1–5;* Boud. Ic. Myc. *pl. 406.*

Our plants agree well with Boudier's illustrations of what he takes to be Hedwig's species. It also agrees fairly well with Hedwig's illustration although the plants are somewhat paler. The species differs from *L. Constellatio* by the smaller size of the plants and much paler color.

15. **Lamprospora Constellatio** (Berk. & Br.)

Peziza Constellatio Berk. & Br. Ann. Mag. Nat. Hist. IV. **17**: 142. 1876.

Leucoloma Constellatio Rehm, Ber. Naturh. Ver. Augsburg **26**: 5. 1881.

Pulvinula Constellatio Boud. Bull. Soc. Myc. Fr. **1**: 107. 1885.

Aleuria Constellatio Gill. Champ. Fr. Discom. 207. (1888?)

Barlaeina Constellatio Morgan, Jour. Myc. **8**: 188. 1902.

Plants gregarious or scattered, at first globose, becoming expanded and plane or slightly concave, 1–5 mm. in diameter, hymenium bright red, color becoming brighter in dried specimens, often almost scarlet, externally lighter; asci cylindric or subcylindric, about 250–300 × 20 μ; with a long stem-like base; spores smooth with one large oil-drop often surrounded by numerous smaller ones, hyaline, 15–20 μ (usually about 18) in diameter, hyaline; paraphyses filiform, only slightly thickened at the ends and very much hooked and curved, entirely filled with red granules and sparingly septate.

On bare ground in rich soil.

TYPE LOCALITY: Addington, Kent, Great Britain.

DISTRIBUTION: New Jersey to Ontario, Colorado and Jamaica; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 407;* Cooke, Mycogr. *pl. 21, f. 81.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *2036.*

I have not seen the type of this species but American specimens conform well with European illustrations and exsiccati. The species was frequently collected by the writer in the Rocky Mountains and has been less frequently collected in the East.

16. **Lamprospora gemma** (Phill.)

Peziza gemma Phill. Grevillea **7**: 21. 1878.

Barlaea gemma Sacc. Syll. Fung. **8**: 112. 1889.

Plants gregarious, sessile, fleshy, subturbinate, finally expanded with the hymenium plane or slightly concave, asci cylindric; spores 1-seriate, globose, smooth, hyaline, about 8 μ in diameter; paraphyses filiform, very slender and branched, straight or more or less curved at their apices.

On decaying foliage of *Sequoia sempervirens.*

TYPE LOCALITY: California.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATION: Cooke, Mycogr. *pl. 111, f. 398.*

A specimen of this species collected by Harkness in California has been examined. The species differs from *L. Constellatio* in the much smaller size of the spores. The plants are also much smaller.

17. **Lamprospora discoidea** (P. Henn. & E. Nym.)

Barlaea discoidea P. Henn. & E. Nym. Monsunia **1**: 33. 1900.
Barlaeina discoidea Sacc. Syll. Fung. **16**: 710. 1902.

Plants scattered or gregarious, sessile, at first subglobose, expanding leaving the margin elevated and hymenium slightly concave, but soon becoming plane and later strongly convex, minutely roughened by the protruding asci, entire plant reaching a maximum of 2 mm. in diameter (usually 1 mm. in diameter at maturity), color white or grayish white or with a slight tinge of yellow or cream; asci subcylindric above, tapering below into a slender stem-like base which is usually forked, about 200–250 $\times$ 20 μ; spores 1-seriate, smooth, with one large oil-drop which nearly fills the spore, rather thick-walled, 15–20 μ in diameter (usually about 17 μ), hyaline; paraphyses slender, slightly enlarged upwards, about 5 μ in diameter at their apices.

On rather sandy soil or among moss.

TYPE LOCALITY: Java.

DISTRIBUTION: New York; also in Asia.

The pale color is the distinguishing character of this species, which was found to be very common in the New York Botanical Garden during the past season. It is very different in appearance from any of the other species here described.

18. **Lamprospora trachycarpa** (Curr.)

Peziza trachycarpa Curr. Trans. Linn. Soc. **24**: 493. 1864.
Peziza scabrosa Cooke, Mycogr. 170. (1879?)
Discina trachycarpa Karst. Act. Fauna Fl. Fenn. **2**: 113. 1885.
Plicaria trachycarpa Boud. Bull. Soc. Myc. Fr. **1**: 102. 1885.
Aleuria trachycarpa Gill. Champ. Fr. Discom. 207. (1888?)
Detonia trachycarpa Sacc. Syll. Fung. **8**: 105. 1889.

Phaeopezia scabrosa Sacc. Syll. Fung. **8**: 472. 1889.
Plicariella trachycarpa Rehm, Rabenh. Krypt. Fl. **1**[3]: 996. 1896.

Plants gregarious or densely crowded, often forming continuous masses extending over many cm., at first globose, gradually opening above and becoming shallow cup-shaped with the margin incurved and elevated or more rarely closely adhering to the substratum, regular in form or cochleate and becoming very irregular especially when closely crowded, hymenium smooth or convolute, dark reddish-brown or slightly olivaceous, becoming black in dried specimens, externally lighter colored and rough, often densely verrucose, 5 mm. to 2 cm. in diameter; asci cylindric or subcylindric, about 15–18 μ in diameter and of variable length but often reaching 250–300 μ; spores 1-seriate, at first smooth, becoming rough, roughenings taking the form of small tubercles or often elongated, appearing like very short interrupted ridges, becoming pale yellowish or smoky at maturity, about 15–18 μ in diameter; paraphyses thickened above and adhering more or less together at their apices, yellowish-brown.

On burnt ground and charcoal beds.

TYPE LOCALITY: Ascot Heath, Great Britain.

DISTRIBUTION: New York to Colorado; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 300;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 14, f. 1;* Cooke, Mycogr. *pl. 67, f. 257;* Trans. Linn. Soc. **24**: *pl. 51, f. 3, 5.*

Cotype material of this species has been examined. Also cotype material of *Peziza scabrosa* Cooke has been examined and found to be identical. The species is common.

19. **Lamprospora nigrans** (Morgan)

Peziza nigrans Morgan, Jour. Cin. Soc. Nat. Hist. **18**: 43. 1895.
Detonia nigrans Sacc. Syll. Fung. **14**: 747. 1899.

Plants at first cup-shaped and circular in outline, becoming plane and more or less irregular, hymenium black or blackish, externally smoky-pallid and smooth, attached to the soil by slender fibers, reaching a diameter of 1 or 2 cm.; asci cylindric or subcylindric and much elongated; spores 1-seriate, at first smooth, becoming rather coarsely warted and reaching a diameter of about 9 μ, subhyaline to smoky-brown; paraphyses thickened above and dark colored.

On burnt ground.

TYPE LOCALITY: Preston, Ohio.

DISTRIBUTION: Known only from the type locality.

The species is distinguished from *L. trachycarpa* to which it is closely related by the smooth exterior of the plants and the very small size of the asci and spores. Cotype material has been studied.

20. **Lamprospora leiocarpa** (Curr.)

Peziza leiocarpa Curr. Trans. Linn. Soc. **24**: 493. 1864.
Plicaria foveata Fuckel, Symb. Myc. 326. 1869.
Detonia leiocarpa Sacc. Syll. Fung. **8**: 105. 1889.
Detonia foveata Sacc. Syll. Fung. **8**: 105. 1889.
Plicaria leiocarpa Rehm, Rabenh. Krypt. Fl. 1^3: 994. 1896.

Plants gregarious, at first globose and closed, opening and becoming shallow cup-shaped, at length almost entirely flattened, and irregularly undulated and lobed, hymenium olivaceous-brown; asci clavate, becoming subcylindric; spores at first irregularly 2-seriate, becoming 1-seriate at maturity, globose, hyaline, remaining entirely smooth, usually with one large oil-drop, about 10–12 μ in diameter; paraphyses enlarged above and adhering together.

On burnt ground.

TYPE LOCALITY: Ascot Heath, Great Britain.

DISTRIBUTION: California; also in Europe.

ILLUSTRATIONS: Trans. Linn. Soc. **24**: *pl. 51, f. 4, 6;* Boud. Ic. Myc. *pl. 304.*

Cotype material of this species has been examined. The only American specimens examined were collected by Dr. Harkness in California. This species differs from *L. trachycarpa,* which it resembles, in having permanently smooth spores.

21. **Lamprospora Planchonis** (Dun.)

Plicaria Planchonis Dun.; Boud. Bull. Soc. Myc. Fr. **3**: 92. 1887.

Plants gregarious or scattered, sessile, hemispherical or nearly plane, usually regular in form but occasionally irregularly contorted, margin rough, exterior of cups minutely roughened or warted, entire plant very dark purple, exterior almost black, hymenium a little lighter, flesh with transmitted light bright

purple and both asci and paraphyses surrounded with purple coloring matter which can be partially extracted with water from the dried plants, 5–8 mm. in diameter; asci cylindric, with a slender stem, about 200 × 13–15 μ; spores 1-seriate, perfectly globose, at first hyaline with one and sometimes several oil-drops, becoming pale purplish (as are also the paraphyses and asci), smooth or very minutely roughened, at maturity about 10–12 μ in diameter; paraphyses clavate, about 6 μ in diameter at their apices, filled with purple granules.

On sandy soil by roadsides, hillsides and on sand-dunes.

TYPE LOCALITY: France.

DISTRIBUTION: Common in the Bermudas; also in Europe.

ILLUSTRATIONS: Bull. Soc. Myc. Fr. **3**: *pl. 8;* Boud. Ic. Myc. *pl. 309.*

This little purple fungus is the commonest cup-fungus in the Bermudas, occurring by roadsides and on hillsides in pastures and open places. Numerous collections were made by Stewardson Brown, N. L. Britton and the writer during the winter of 1912. So far as I am aware, this is the first record of the species from North America. A closely related species, *Peziza Persoonii,* is said to differ in having rough spores. No specimen of the latter species has been seen by the writer from North America.

22. **Lamprospora lobata** (Berk. & Curt.)

Peziza lobata Berk. & Curt. Jour. Linn. Soc. **10**: 365. 1869.
Barlaea lobata Sacc. Syll. Fung. **8**: 117. 1889.

Plants scattered, and shallow cup-shaped to nearly plane or with the margin slightly elevated and undulated or lobed; hymenium dull orange, paler below, about 5–12 mm. in diameter; asci cylindric or subcylindric, 15–18 μ in diameter and of variable length but usually about 250 μ; spores 1-seriate, at first smooth, becoming rough at maturity, roughenings consisting of four to six tubercles of variable size which appear beyond the periphery of the spore and with several more or less indistinct lines or bands extending across the surface of the spore in various directions resembling pieces of coarse twine wound about its surface, the inequality in the size of the tubercles giving the mature spore a rather irregular form, entire spore 12–15 μ in diameter, hyaline; paraphyses very slender, about 1–2 μ in diameter and scarcely enlarged at their apices.

On the ground.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATIONS: Cooke, Mycogr. *pl. 69, f. 265.*

A cotype specimen of this species has been studied. The species is well-marked by its size and by the peculiar markings of the spores, which are not mentioned in the original description.

23. **Lamprospora polytrichina** (Rehm)

Detonia polytrichina Rehm, Krypt. Fl. 1[3]: 1269. 1896.

Plants gregarious, sessile, expanding, becoming nearly plane or shallow cup-shaped, margin entire and often wavy, reaching a diameter of 5 mm., hymenium bright orange, externally lighter. straight or slightly curved.
whitish and more or less pruinose; asci cylindric or subcylindric, gradually tapering near the base, reaching a length of 200–225 μ and about 17 μ thick near the apex; spores 1-seriate, entirely globose, with one or sometimes several oil-drops, smooth, hyaline, 15–17 μ in diameter; paraphyses slender, slightly enlarged above,

On soil among moss, especially *Polytrichum.*

TYPE LOCALITY: Europe.

DISTRIBUTION: Minnesota; also in Europe.

ILLUSTRATIONS: Cooke, Mycogr. *pl. 13, f. 50.*

The only specimens of this species examined from America were those collected by Miss Hone in Minnesota (No. *938*). The species has been confused with *Peziza Polytrichi* Schum.

DOUBTFUL SPECIES

Peziza exasperata Berk. & Curt. Grevillea 3: 152. 1874.

The plants are described as one-half inch across, externally warted and with the margin inflexed, spores rough and about 12 μ in diameter.

The species was collected in Alabama by Peters.

Peziza globifera Berk. & Curt. Jour. Linn. Soc. 10: 366. 1869.

A Cuban species with smooth spores. My only knowledge of this and the preceding species is based on the examination of microscopic slide of the spores.

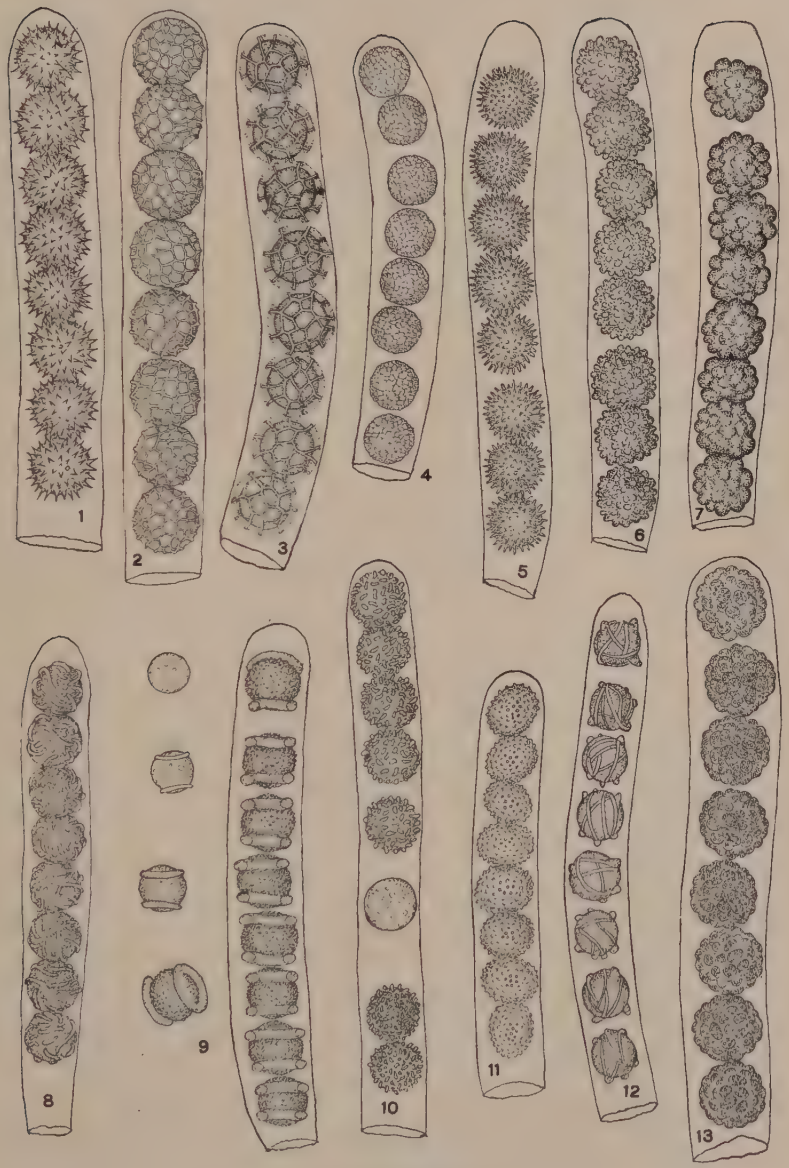
Barlaea lacunosa Ellis & Ev. Proc. Acad. Nat. Sci. Phila. 1894: 347. 1895.

This species was described from material collected on the bark of some coniferous tree in Newfoundland. The type has been studied and both the habitat and general characters of the plant indicate that it is a *Pithya,* which genus is rather closely related to *Lamprospora.* Whether it is a distinct species I am unable to say. The plants are larger and more convolute than most specimens of *Pitya vulgaris* Fuckel, but some specimens of this species approach it in size. If it is not the same species, Ellis's plant is at least very closely related to *P. vulgaris.*

EXPLANATION OF PLATE CXIV

This plate contains spores of the following species of *Lamprospora* drawn with the aid of the camera lucida to a common scale.

1. *Lamprospora Crec'hqueraultii* (Crouan) Boud.
2. *Lamprospora Crouani* (Cooke) Seaver.
3. *Lamprospora areolata* Seaver.
4. *Lamprospora dictydiola* Boud.
5. *Lamprospora spinulosa* Seaver.
6. *Lamprospora tuberculatella* Seaver.
7. *Lamprospora tuberculata* Seaver.
8. *Lamprospora ascoboloides* Seaver.
9. *Lamprospora annulata* Seaver.
10. *Lamprospora trachycarpa* (Curr.) Seaver.
11. *Lamprospora Wrightii* (Berk. & Curt.) Seaver.
12. *Lamprospora lobata* (Berk. & Curt.) Seaver.
13. *Lamprospora Maireana* Seaver.



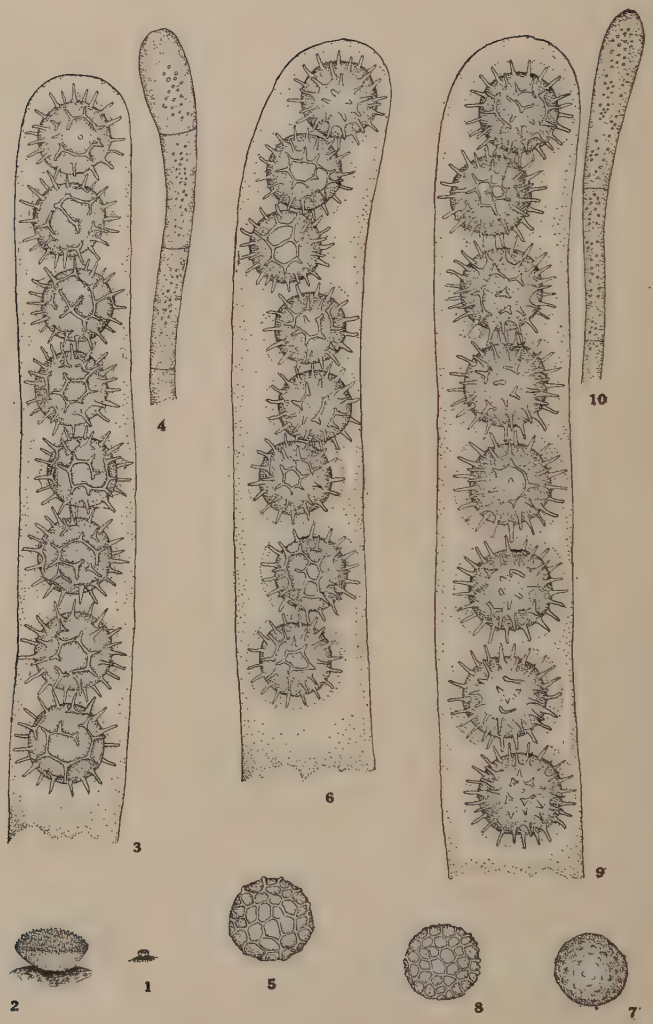
LAMPROSPORA

No 34

OBSERVATIONS ON SPHAEROSOMA AND ALLIED GENERA

By FRED. J. SEAVER

Reprinted from MYCOLOGIA, Vol. VI, No. 3, May, 1914



BOUDIERA AREOLATA COOKE & PHILL.
SPHAEROSOMA ECHINULATUM SEAVER

[Reprinted from MYCOLOGIA, Vol. VI., No. 4, May, 1914.]

OBSERVATIONS ON SPHAEROSOMA AND ALLIED GENERA

FRED. J. SEAVER

(WITH PLATE 123, CONTAINING 10 FIGURES)

In response to a paper recently published on the genus *Lamprospora*,[1] the writer has received from Doctor Roland Thaxter a very interesting plant which it was suggested might belong to that genus, or, possibly, to the genus *Boudiera*. Examination of the spores and paraphyses of this plant, which was collected at Kittery Point, Maine, led the writer to suspect that it was very closely related to *Sphaerosoma echinulatum* of the writer.[2] In fact the spores and paraphyses scarcely differed from those of my own plant. A later examination of the entire plant showed considerable difference in the gross characters of the two, the Maine plant resembling in general appearance a *Lamprospora* rather than a *Sphaerosoma*. In spite of this fact, however, there was sufficient similarity between the two to suggest that they were, at least, very closely related.

The study of this plant has suggested a review of the facts regarding the identity of the genus *Sphaerosoma* and its relation to other genera of the discomycetes. Several papers have recently appeared on this subject, but there are still a number of points which are not entirely clear. Many of these questions will never be cleared up until the species of *Sphaerosoma* are collected in sufficient quantity to make a careful morphological study of the

1 MYCOLOGIA 6: 5–24. *pl. 114.* 1914.

2 Jour. Myc. 11: 2–6. *pl. 75.* 1905.

[MYCOLOGIA for March, 1914 (6: 49–102), was issued March 18, 1914].

genus and its relation to other genera. In the meantime, mycologists will continue to speculate on the probable relationship of *Sphacrosoma* to other genera, as best they can, with the limited knowledge based of the scant material which is available.

The genus *Sphacrosoma* was founded by Klotzsch on *S. fuscescens*. As pointed out by Professor Setchell,[3] there have been various interpretations as to the exact character of the spores of this species, some describing them as echinulate, others as reticulate, and still others as verrucose. Professor Setchell in assuming that the spores in *Sphacrosoma fuscescens* were echinulate has suggested that this type of plant be regarded as the true *Sphaerosoma* and has followed Hennings[4] in treating the reticulate-spored species in the separate genus *Ruhlandiella*. In describing his Californian species, it was therefore placed in the genus *Ruhlandiella* since the spores were reticulate.

The writer has recently examined a specimen of *Sphacrosoma fuscescens* collected in Germany by Klotzsch. While this specimen is not actually marked type, we have reason to believe that it is a part of the type collection. At least, it is probably as authentic as any material that can be had. The spores of this plant are deeply areolate or reticulate, the ridges of the areolae extending two or three microns beyond the periphery of the spore and often appearing as short spines. The spore characters of this plant are very similar to those of *Ruhlandiella hesperia* Setchell, a specimen of the type of this latter species having been examined by the writer through the kindness of Professor Setchell. From the nature of the spores, it is not difficult to account for the description of the spores as both reticulate and echinulate.

It is not even difficult to understand how the spores might have been described as verrucose when we recall that most of the reticulate-spored discomycetes were originally described with verrucose spores. *Peziza Crouani* was so described by Phillips and *Peziza aurantia* has been repeatedly described and illustrated with verrucose spores, although both species have spores which are distinctly reticulate. Even with the microscopes used at the present time, it is often difficult to make out the exact nature of the

[3] Univ. Calif. Pub. 4: 107–118. *pl. 15.* 1910.
[4] Hedwigia 42: (22). 1903.

spore markings in some of these species, and they may even be interpreted differently by different observers. It is possible, however, as suggested by Professor Setchell that Corda[5] had the wrong plant.

Whatever view we accept with reference to Corda's illustration and the accompanying description, the fact remains that Klotzsch's plant examined by the writer shows the spores to be reticulate, and I am therefore compelled to agree with Roupert[6] as to the character of the spores in *Sphaerosoma fuscescens* Klotzsch. Professor Setchell's plant would then according to this view be a true *Sphaerosoma* and rather closely related to the type species.

The suggestion that the Maine plant might be a *Boudiera* and possibly *B. areolata* Cooke & Phill.[7] together with the fact that this eastern plant was found to have spores almost identical with my own *Sphaerosoma echinulatum* from Iowa, has prompted a more thorough investigation of the character of the European *Boudiera areolata*. Fortunately, I have been able to examine a specimen of this species collected in North Wales and which is apparently a part of the type. To my surprise I find that the mature spores of this species are strongly echinulate and so far as I am able to judge identical with Thaxter's plant and my own, although it is possible that the areolae are a little less distinct in the Iowa plant than in the other two. In the original description of *Sphaerosoma echinulatum* the following note was appended referring to the spores: "Microscopic examination shows on the surface in addition to the spines markings which resemble reticulations, but these are short and not continuous and are not seen at the periphery of the spore, so that they are probably only spines bent so as to give this appearance." From this it will be seen that the semi-reticulate character of the spores was noted in the Iowa plants, although possibly misinterpreted. The spores of the three plants examined might be described at maturity as echino-reticulate with a strong emphasis on the "echini." The spores in both the Iowa and the European plant, however, show a variety of changes in the course of their development. The very young spore is smooth later becoming slightly roughened, the roughenings in

5 Corda, Icones Fung. 6: 52. *pl. 11, f. 100.* 1854.
6 Bull. Acad. Sci. Cracovie 1909: 76–95. 1909.
7 Grevillea 6: 76. 1877.

the partly matured spore often taking the form of reticulations, the ridges becoming more pronounced about the periphery of the spore until at maturity they appear echinulate with the spines connected by the broken and interrupted ridges mentioned above. The intermediate forms were not seen in the Maine plant for lack of material. All at maturity are pale yellowish-brown.

From the above observations it is evident that we have three plants with spores which are, so far as I am able to determine, identical, *i. e., Boudiera areolata* Cooke & Phill., *Sphaerosoma echinulatum* of the writer and the unnamed plant collected by Dr. Thaxter in Maine. From the gross characters, however, I would not suspect that Dr. Thaxter's plant is the same as my own. The plants in the former are smaller, subturbinate, with the hymenium convex and asci strongly protruding. In the latter the plants are larger, flattened below, with the hymenium forming almost a complete semi-circle and the protruding asci not evident, although it is possible that this latter character might have been overlooked in the Iowa plants. When we take into consideration the fact that only five plants were collected in Maine and several hundred in Iowa, it is possible that these apparent differences in gross characters might fade out if the eastern plant could be collected in larger quantity.

Dr. Thaxter's plants accord more closely with early illustrations of *Boudiera areolata* Cooke & Phill. than do my own. However, after studying part of the type of *B. areolata* the writer is convinced that *Sphaerosoma echinulatum* is only an American form of *Boudiera areolata* of European authors. That this is a European species is evident from the fact that the species has been collected twice in Europe since its description from Iowa material, but each time it has been referred to the name given to the American plant with no suggestion that it had been previously described in Europe. The illustration of *Boudiera areolata* by Boudier[8] fits *Sphaerosoma echinulatum* so far as gross characters and color are concerned. The section, however, shows the hymenium as occupying the upper surface only and in this it does not agree with the *S. echinulatum*. This sketch, however, may be diagrammatic.

The habitats of three collections also show a striking similarity. The European plant was originally collected by William Phillips

[8] Boudier, Ic. Myc. *pl. 417.* 1909.

in North Wales and was said to grow on moist ground on the margin of a lake. The habitat of the Maine plant was given by the collector as follows: "It was growing on bare clay mud, where cattle had stamped around a small pond which dries up in midsummer." Dr. Thaxter states that although the original locality has been visited many times since the original collection was made, no more of the plants could be found. My own plants were collected in a pasture at the foot of two small ravines in a depression which is wet a good part of the year. Here cattle had tramped about until the ground was very uneven with standing water in the low places. The plants grew on the bare clayey soil about the margin and on the elevated portions which were very wet. The type locality has been visited only once since the original collection was made in 1904. The latter visit was during the summer of 1912. A special search was made for the plant at this time. The season did not appear to be favorable, but a few immature plants were found, so that I have reason to believe that the species occurs in that locality regularly when the conditions are favorable. At the time of the original collection, two other discomycetes were found growing in company with it, *Ascobolus viridis* and *Lamprospora Crec'hqueraultii*. Both of these plants were found to be present at the time of the last visit.

The genus *Boudiera* was founded by Cooke on *Boudiera areolata*. The genus was placed in the Ascobolaceae apparently on account of the protruding asci, a character which was thought to be restricted to the Ascobolaceae, and in fact one of the characters on which the family is segregated. This character is common to a number of the Pezizaceae, including members of the genus *Lamprospora*, as has been previously noted. The fact that *Boudiera* is often described as having violet spores and is made to include plants of a coprophilous habitat is likely to be misleading, since the type species shows neither of these characters.

If the genus *Boudiera* as represented by the type species is to be retained as a separate genus, it must be regarded as a close relative of *Lamprospora* on the one hand and as showing at least a superficial resemblance to *Sphaerosoma* on the other. Whether this superficial resemblance is an indication of close natural relationship remains to be seen. This resemblance was noted by

Cooke[9] when he stated in referring to *Boudiera,* "in some respects allied also to *Sphaerosoma.*"

Several of the points raised in the present paper are purposely left open with the hope that additional material collected in the field will help to settle some of the questions which are here only suggested.

CONCLUSIONS

The spores of *Sphaerosoma fuscescens* Klotzsch, type of the genus *Sphaerosoma,* are reticulate and not echinulate as concluded by Professor Setchell. *Ruhlandiella hesperia* Setchell is then a true *Sphaerosoma* and closely resembles the type species.

Sphaerosoma echinulatum Seaver is a plant closely resembling *Boudiera areolata* Cooke & Phill. and is probably only an American form of that species and not a true *Sphaerosoma* at all.

Boudiera as represented by *B. areolata* is a genus closely allied to *Lamprospora* on the one hand and showing at least a superficial resemblance to *Sphaerosoma* on the other, a fact which was noted by Cooke, the author of the genus. Whether this resemblance is any indication of natural relationship is a question.

The unnamed plant collected by Dr. Thaxter in Maine, although showing some differences in gross characters, closely resembles in microscopic details *Sphaerosoma echinulatum* of the writer and both are, so far as I can determine, identical in spore characters with *Boudiera areolata* of European authors. Whether the apparent differences in gross characters are of specific importance can be determined only by the collection and study of more abundant field material.

EXPLANATION OF PLATE CXXIII

Spores and paraphyses drawn with the aid of the camera lucida to a common scale and with the same combination of lenses used in drawings of *Lamprospora* spores, MYCOLOGIA 6: *pl. 114.*

1–4. *Boudiera* sp. from plant collected by Thaxter in Maine, 1, plant about natural size; 2, plant × 7; 3–4, ascus with spores and paraphysis × 450.

5–6. *Boudiera areolata* Cooke & Phill.; 5, partially matured spore; 6, ascus with mature spores × 450. Drawn from material collected in North Wales and apparently a part of the type.

7–10. *Sphaerosoma echinolatum* Seaver; 7, young spore; 8, partially matured spore; 9 and 10, ascus with spores and paraphysis × 450. Drawn from type.

[9] Grevillea 7: 57. 1878.

No 35

NORTH AMERICAN SPECIES OF ALEURIA AND ALEURINA

FRED J. SEAVER

Reprinted from MYCOLOGIA, Vol. VI, No. 6, November, 1914

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NORTH AMERICAN SPECIES OF ALEURIA AND ALEURINA

(WITH PLATES 142–144, CONTAINING 10 FIGURES)

FRED J. SEAVER

The genus *Aleuria* was founded by Fuckel, and originally comprised the two species *Aleuria aurantia* (Pers.) Fuckel and *Aleuria rhenana,* the latter species described by the author of the genus. The genus has been used in various ways but in recent years has come to be restricted by some writers to the reticulate-spored species of Pezizeae and in this sense it is here employed. Four such species are known to North America, all of which are characterized by the bright orange color of the hymenium with the whitish exterior. The habitats of the four species are quite distinct and three of these are shown in the accompanying photographs.

Aleurina was used by Saccardo as a subgenus of *Phaeopezia* and differs from *Aleuria* in that the spores are colored. While the reticulations in the spores of the type species are less distinct than in the various species of *Aleuria,* there is a strong resemblance between the markings of the spores of the various species of *Aleuria* and the type species of *Aleurina,* which is here regarded as a distinct genus. *Peziza retiderma,* which was made the type of Saccardo's subgenus, was originally described from material collected at Portland, Maine. Recent collections of this species at Portland, Connecticut, has furnished material for the accompanying illustrations and descriptions.

ALEURIA Fuckel, Symb. Myc. 325. 1869

Plants gregarious, scattered or cespitose, sessile or stipitate, fleshy, bright-colored, smooth or clothed externally with delicate white mycelium; asci cylindric, 8-spored; spores ellipsoid, at first smooth, at maturity reticulate.

Type species, *Peziza aurantia* Pers.

Spores not marked with ring at either end.
Plants sessile, at maturity large, reaching a diameter of several cm. *A. aurantia.*
Plants stipitate, medium-sized, seldom exceeding 1 or 2 cm. in diameter.
Plants occurring in coniferous woods, stems usually long and springing from a dense mass of white mycelium.....*A. rhenana.*
Plants occurring among mosses in deciduous woods, stems short and not springing from a dense mass of white mycelium....*A. rutilans.*
Spores marked with a ring at either end.....*A. bicucullata.*

ALEURIA AURANTIA (Pers.) Fuckel, Symb. Myc. 326. 1869

Elvela coccinea Schaeff. Fung. Bavar. 4: 100. 1774. Not *Elvela coccinea* Scop. 1772.

Peziza coccinea Bull. Herb. Fr. *pl. 474.* 1789.

Helvella coccinea Bolton, Fungi Halifax 3: 100. 1789.

Peziza aurantia Pers. Obs. Myc. 2: 76. 1797.

Otidea aurantia Massee, Fungus Fl. 4: 448. 1895.

?Aleuria wisconsinensis Rehm, Ann. Myc. 2: 34. 1904.

Plants gregarious or cespitose, at first globose, opening with a circular aperture and gradually expanding, at maturity varying in size from a few mm. to 5 or 6 cm. (rarely even larger), shallow cup-shaped and usually regular in form when young becoming irregular and often variously contorted with age, often from mutual pressure, rarely one sided and *Otidea*-like, occasionally discoid with the hymenium almost plane, bright-orange within, color fading in dried specimens, externally whitish-pruinose; asci cylindric or subcylindric, 12–15 μ in diameter and 175–250 μ long; spores 1-seriate, usually obliquely arranged in the ascus with the ends often overlapping, at first smooth and usually containing two (rarely more) large oil-drops, at maturity rough, roughenings taking the form of reticulations which are shallow and usually with one, rarely two, prominent projections at either end, 18–22 $\times$ 9–10 μ when mature, a little smaller when young; paraphyses strongly and rather abruptly enlarged above, often with the ends subglobose, reaching a diameter of 7 or 8 μ, filled with orange granules.

On naked soil in woods or open places, often on clayey soil.

TYPE LOCALITY: Europe.

DISTRIBUTION: Newfoundland to Washington, California and West Virginia; also in Europe.

ILLUSTRATIONS: Bolton, Fungi Halifax, *pl. 100;* Bull. Herb. Fr. *pl. 474;* Bull. Lab. Nat. Hist. State Univ. Iowa, 6: *pl. 17, f. 1;* Cooke, Mycogr. *pl. 52, f. 203;* Fl. Danici *pl. 157;* Schaeff. Fung. Bavar. *pl. 148;* Sow. Engl. Fungi *pl. 78;* Boud. Ic. Myc. *pl. 313.*

EXSICCATI: Ellis, N. Am. Fungi *836;* Ellis & Ev. Fungi Columb. *15.*

ALEURIA RHENANA Fuckel, Symb. Myc. 325. 1869

?Peziza radiculata Sow. Engl. Fungi *pl. 114* (with descr.) 1797.
Peziza splendens Quél. Champ. Jura 388. 1872.
Sarcoscypha rhenana Sacc. Syll. Fung. 8: 157. 1889.
?Sarcoscypha radiculata Sacc. Syll. Fung. 8: 156. 1889.

Plants gregarious or cespitose, stipitate with the stems variable in length but reaching 1 or 2 cm., irregular, tomentose and attached by a dense growth of white mycelium which penetrates into the substratum binding together the leaves, twigs and leaf-mould in which they grow, the stems themselves often clinging together in clusters, abruptly expanding above into the cup which reaches a diameter of 1 or 2 cm. and about half as deep, exterior of the cup and stem white or whitish, the cups pruinose or subtomentose with poorly developed hair-like structures, hymenium bright-orange, color fading in dried specimens; asci cylindric above, tapering below, reaching a length of 300–350 μ and 15–17 μ thick, often becoming strongly spirally twisted at least in dried specimens; spores 1-seriate, obliquely arranged and often with the ends slightly overlapping, ellipsoid, at first smooth and with usually two large oil-drops, becoming rough, roughenings taking the form of reticulations with the meshes of the reticulations about 3 μ in diameter, rarely 5 or 6 μ, ridges extending 1–2 μ beyond the periphery of the spore, entire spore 23–27 $\times$ 12–16 μ; paraphyses enlarged above, about 6 μ in diameter, filled with orange granules.

On the ground in coniferous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: Pennsylvania to Alabama and west to Washington.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 314;* Cooke Mycogr. *pl. 112, f. 400.*

ALEURIA RUTILANS (Fries) Gill. Champ. Fr. Discom. 53. 1879

Peziza rutilans Fries, Syst. Myc. **2**: 68. 1822.

Leucoloma rutilans Fuckel, Symb. Myc. 318. 1869.

Humaria rutilans Sacc. Syll. Fung. **8**: 133.

Sarcoscypha albovillosa Rehm, Ann. Myc. **2**: 33. 1904.

Plants gregarious or scattered, stipitate with the stem short, about 2 mm. thick and gradually expanding above into the cup and reaching a maximum length of about 5 mm., cup at first closed and of about the same diameter as the stem, gradually expanding and becoming turbinate with the margin more or less crenate and fringed, hymenium bright-orange, externally paler and tomentose, or with a few pale hairs about the margin of the cup, reaching a diameter of 1 cm. or occasionally larger; asci cylindric or subcylindric, gradually tapering below into a stem-like base, 300–350 × 20 μ; spores usually 1-seriate, obliquely arranged in the ascus with the ends overlapping, containing usually one or more, rarely two, large oil-drops and often several smaller ones, at maturity delicately reticulated, reticulations sometimes indistinct and broken, ellipsoid with the ends somewhat narrowed, 20–25 × 12–14 μ; paraphyses slightly enlarged above and densely filled with oil-drops and granules, about 4 μ in diameter at their apices.

On soil among mosses (especially *Polytrichum*), apparently growing on the dead leaves and often hidden by the living plants.

TYPE LOCALITY: Europe.

DISTRIBUTION: New Hampshire and New York to Iowa; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 315;* Grevillea **22**: 108, *f. 1–6;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 17, f. 2.*

ALEURIA BICUCULLATA Boud. Bull. Bot. Soc. Fr. **28**: 93. 1881

Peziza bicucullata Boud. Bull. Soc. Myc. Fr. **1**: 103. 1885.

Humaria bicucullata Quél. Ench. Fung. 288. 1886.

Plants gregarious or crowded, at first subglobose, expanding and at maturity subdiscoid or often irregular from mutual pressure, 5 mm. to 1 cm. in diameter, at maturity pale-orange, externally a little paler and minutely roughened; asci cylindric above, reaching a diameter of 12–15 μ; spores obliquely 1-seriate and closely pressed together and showing a ring-like or hood-like process at either end on being separated, smooth and containing one or two oil-drops, at maturity strongly roughened, roughen-

ings taking the form of irregular and often broken reticulations, ridges of reticulations conspicuous and giving rise to rather sharp-pointed spine-like projections, terminal projections larger and giving the spore an apiculate appearance, entire spore 20–23 × 10–12 μ (including roughenings); paraphyses rather strongly enlarged above where they reach a diameter of about 5 μ.

On bare ground or among mosses.

TYPE LOCALITY: France.

DISTRIBUTION: Wisconsin; also in Europe.

ILLUSTRATIONS: Bull. Soc. Bot. Fr. 28: *pl. 3, f. 3;* Boud. Ic. Myc. *pl. 318.*

Aleurina (Sacc.) Seaver, gen. nov.

Phaeopezia § *Aleurina* Sacc. Syll. Fung. 8: 472. 1889.

Plants medium sized, cup-shaped, fleshy or subfleshy dark-colored; asci 8-spored; spores ellipsoid, at first hyaline, becoming smoky-brown, rough, roughenings often taking the form of indistinct reticulations; paraphyses stout.

Type species, *Peziza retiderma* Cooke.

Aleurina retiderma (Cooke)

Peziza retiderma Cooke, Mycographia 176. (1877.)

Phaeopezia retiderma Sacc. Syll. Fung. 8: 472. 1889.

Plants gregarious or occasionally cespitose, rather deep cup-shaped, regular in form or becoming irregularly contorted, irregularity often resulting from mutual pressure, at first brown and lighter externally, hymenium soon becoming darker and at maturity almost black, exterior also becoming darker but remaining lighter than the hymenium, reaching a diameter of 2–5 cm. at maturity; asci cylindric above, rather abruptly tapering below into a stem-like base, reaching a length of 275 μ and a diameter of 12–14 μ; spores 1-seriate, ellipsoid, at first hyaline, smooth and containing one or two oil-drops, gradually becoming roughened, smoky-brown, roughenings usually giving rise to one large protuberance at either end of the spore and irregular reticulate markings over the surface of the spore, the reticulate ridges so arranged as to give the spore a somewhat striate appearance, entire spore at maturity 15–17 × 10 μ; paraphyses strongly enlarged above, where they reach a diameter of 8 μ, minutely granular within and dilutely colored.

On the ground in woods often among mosses.

TYPE LOCALITY: Portland, Maine.

DISTRIBUTION: New York to Maine and Wisconsin.

ILLUSTRATION: Cooke, Mycographia, *pl. 79, f. 306.*

Aleurina aquehongensis sp. nov.

Plants gregarious or scattered, sessile, discoid to shallow cup-shaped, reaching a diameter of about 1 cm., externally slightly roughened, entirely brownish-black, with a slightly greenish tint to the hymenium which appears to be due to the spores which have dusted out of the asci; asci cylindric above, tapering below into a rather irregular stem-like base, reaching a length of 300–350 μ and a diameter of 15–17 μ; spores 1-seriate or occasionally slightly crowded, ellipsoid to subfusoid with the ends narrowed and containing one or two oil-drops, at first smooth, becoming rough, roughenings taking the form of irregular reticulations, mature spore 22–25 $\times$ 10–12 μ, hyaline, becoming pale smoky-brown, color more or less evanescent; paraphyses rather strongly enlarged above, reaching a diameter of 6 μ, pale-brown.

On the ground in a damp place.

Type collected by N. L. Britton and F. J. Seaver near Oakwood Heights, Staten Island, September 5, 1914.

DISTRIBUTION: Known only from the type locality.

EXPLANATION OF PLATES CXLII–CXLIV

PLATE CXLII

Upper figure, *Aleuria rutilans* (Fries) Gill. Photographed from material collected at Hudson Falls, New York, by Mr. Stewart H. Burnham.

Lower figures, *Aleuria rhenana* Fuckel. Photographed from material collected at Mill City, Oregon, by Dr. W. A. Murrill.

PLATE CXLIII

Upper figure, *Aleuria aurantia* (Pers.) Fuckel. Photographed from material collected in the New York Botanical Garden, by the writer.

Lower figure, *Aleurina retiderma* (Cooke) Seaver. Photographed from material collected at Portland, Connecticut, by the writer.

PLATE CXLIV

Spores and paraphyses drawn with the aid of the camera lucida to a common scale. Where the base of the ascus is shown, it is doubled back to save space.

1. *Aleuria aurantia* (Pers.) Fuckel.
2. *Aleuria rhenana* Fuckel. This drawing shows the spirally coiled base of the ascus as it often occurs in this species.
3. *Aleuria bicucullata* Boud.
4. *Aleuria rutilans* (Fries) Gill.
5. *Aleurina aquehongensis* Seaver.
6. *Aleurina retiderma* (Cooke) Sacc.

ALEURIA RUTILANS (FRIES) GILL.
ALEURIA RHENANA FUCKEL

ALEURIA AURANTIA (PERS.) FUCKEL
ALEURINA RETIDERMA (COOKE) SEAVER

ALEURIA AND ALEURINA

No. 3C.

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—I. PEZIZA

Fred J. Seaver

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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—I. PEZIZA

FRED J. SEAVER

(WITH PLATES 155 AND 156, CONTAINING 4 FIGURES)

Although the type of the genus *Peziza* is in doubt, the name stands in current usage as it doubtless should continue to do, for the large fleshy cup-fungi. Notwithstanding the number of segregates which have been made on one character or another, the genus is still represented by a fairly large number of species.

Many of the species of the genus cannot be satisfactorily studied from dried specimens alone, since the more conspicuous characters, such as color, form, etc., are entirely lost in this condition. In a number of species, the spores furnish valuable diagnostic characters, but in other cases we must rely entirely on gross character. For this reason, the species of the genus should be accompanied by complete field notes, or as is still better, by colored sketches or photographs or both.

The reproduction of the plants of this group by photographs while inferior in many ways to reproduction by color, is less expensive and shows many fine details which are lost even in the best colored illustrations. For these reasons, it is the intention to bring out from time to time illustrations of the common species of *Peziza* and other cup-fungi in such a way as to aid in determining the identity of these plants as they are collected in the field. The following illustrations represent four of the common species of *Peziza*, the photographs having been made from local specimens collected by the writer in the vicinity of New York City.

PEZIZA BADIA Pers. Obs. Myc. 2: 78. 1799

?Peziza cochleata L. Sp. Pl. 1181. 1753.
?Helvella cochleata Bolton, Fungi Halifax 3: 99 (in part). 1789.
Plicaria badia Fuckel, Symb. Myc. 327. 1869.
Aleuria badia Gill. Champ. Fr. Discom. 43. 1879.

Apothecia scattered, gregarious or more commonly cespitose, sessile, at first globose, expanding and becoming deep cup-shaped, regular in form, or infolded and cochleate or auricular, occasionally one-sided and rarely *Otidea*-like, externally varying from tan-colored when young to dark-brown with age, whitish near the base, pustulate, the pustules often reddish or purplish, becoming dark with age, reaching a diameter of 10 cm.; hymenium dark-brown; asci tapering below and often forked at the base, cylindric above; spores 1-seriate, usually oblique and often irregularly crowded, ellipsoid, with the ends quite strongly narrowed, becoming verrucose, hyaline or very faintly colored, 17–23 × 8–10 μ; paraphyses rather strongly enlarged above, yellowish.

On the ground in deciduous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Oregon, California and Alabama; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 283;* Bull. Lab. Nat. Hist. State Univ. Iowa 6: *pl. 14, f. 2, pl. 15, f. 1;* Cooke, Mycographia *pl. 57, f. 226;* Gill. Champ. Fr. Discom. *pl. 42.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *981.*

Peziza cochleata of Linnaeus is a species of doubtful identity. Persoon in 1801 described *Peziza badia* and cited as a synonym *Helvella cochleata* Bolton. Bolton apparently included in his description two species, one of which is commonly taken to be identical with *Peziza badia* as at present known. Bolton's *Helvella cochleata* represents his conception of *Peziza cochleata.* Some modern authors are inclined to regard *Peziza cochleata* L. as an *Otidea.* In the absence of any definite information, the writer is inclined to adhere to the early conceptions of Bolton and Persoon and regard *Peziza cochleata* L. as at least a doubtful synonym of the present species.

PEZIZA VESICULOSA Bull. Herb. Fr. *pl. 457.* 1789

Helvella cochleata Bolton, Fungi Halifax 3: 99 (in part). 1789.
Pustularia vesiculosa Fuckel, Symb. Myc. 329. 1869.
Alcuria vesiculosa Gill. Champ. Fr. Discom. 45. 1879.

Apothecia gregarious or more often densely cespitose, at first closed and globose, gradually expanding and becoming deep cup-shaped, regular in form or irregularly contorted, sessile or with

very stout stem-like base, externally whitish or yellowish, pustulate from the presence of minute warts, reaching a diameter of 7–8 cm.; hymenium pale-brown, darker than the exterior of the apothecium; asci cylindric or subcylindric; spores obliquely 1-seriate, ellipsoid, smooth, hyaline, 20–23 × 10–11 μ; paraphyses enlarged above, granular within, subhyaline.

On manure piles and rich soil.

TYPE LOCALITY: France.

DISTRIBUTION: New York to Washington, California and Alabama; probably throughout North America; also in Europe.

ILLUSTRATIONS: Bull. Herb. Fr. *pl. 457;* Boud. Ic. Myc. *pl. 257;* Cooke, Mycographia *pl. 63, f. 242;* Gill. Champ. Fr. Discom. *pl. 44;* Rabenh. Krypt. Fl. 1^3: 992, *f. 1–4;* Bull. Lab. Nat. Hist. State Univ. Iowa 6: *pl. 16, f. 1;* Sowerby, Engl. Fungi *pl. 4;* Massee, Brit. Fungus Fl. 4: 290, *f. 22.*

EXSICCATI: Ellis, N. Am. Fungi *1270.*

PEZIZA PUSTULATA (Hedw.) Pers. Syn. Fung. 646. 1801

Octospora pustulata Hedw. Musc. Frond. 2: 19. 1787.
Plicaria pustulata Fuckel, Symb. Myc. 327. 1869.
Peziza assimilata Karst. Not. Fauna Fl. Fenn. 10: 113. 1869.
Aleuria pustulata Gill. Champ. Fr. Discom. 45. 1879.
Peziza umbrina Boud.; Cooke, Mycographia 226 (in part). 1879.

Apothecia gregarious, scattered or cespitose, at first closed and globose, gradually expanding, reaching a diameter of 3–5 cm., regular or much contorted, externally whitish and densely pustulate, the pustules giving rise to bran-like particles as the plant matures, margin usually crenate; hymenium pale- to dark-brown; asci cylindric above, reaching a length of 275 μ and a diameter of 12–14 μ; spores 1-seriate, ellipsoid, becoming minutely roughened, hyaline to faintly yellowish, 15–17 × 10 μ; paraphyses strongly enlarged and reaching a diameter of 7–8 μ.

On charcoal and burned areas.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Wisconsin; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 279;* Cooke, Mycographia *pl. 106, f. 378;* Grevillea 2: *pl. 24, f. 2;* Hedw. Musc. Frond. 2: pl. 6, *f. 1–4;* Gill. Champ. Fr. Discom. *pl. 47, f. 2.*

Peziza sylvestris (Boud.)

Aleuria sylvestris Boud. Hist. Class. Discom. Eu. 45. 1907.

Apothecia gregarious, sessile, deep cup-shaped to subdiscoid, externally whitish, nearly smooth or pustulate, the margin even or slightly wavy and crenate, reaching a diameter of 3–8 cm.; hymenium umber-brown; asci cylindric above, gradually tapering below, reaching a length of 300–325 μ and a diameter of 13–15 μ; spores 1–seriate, with the ends slightly overlapping, hyaline, smooth, 17–20 $\times$ 9–10 μ; paraphyses strongly enlarged above, reaching a diameter of 7–8 μ at their apices.

On rubbish piles and soil in woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 261.*

The species listed under this name is common about New York City. While agreeing with Boudier's description and illustrations, it is not unlikely that the species has been previously described. From our own observations, the species seems quite variable both in size and appearance, the apothecia being sometimes nearly plane and occasionally strongly warted and then resembling *Peziza bufonia* Pers. The species differs from *Peziza pustulata* in the habitat and in the spores, those of the former being strongly roughened and those of the present species permanently smooth. The size and color of the two species is almost identical.

NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATES

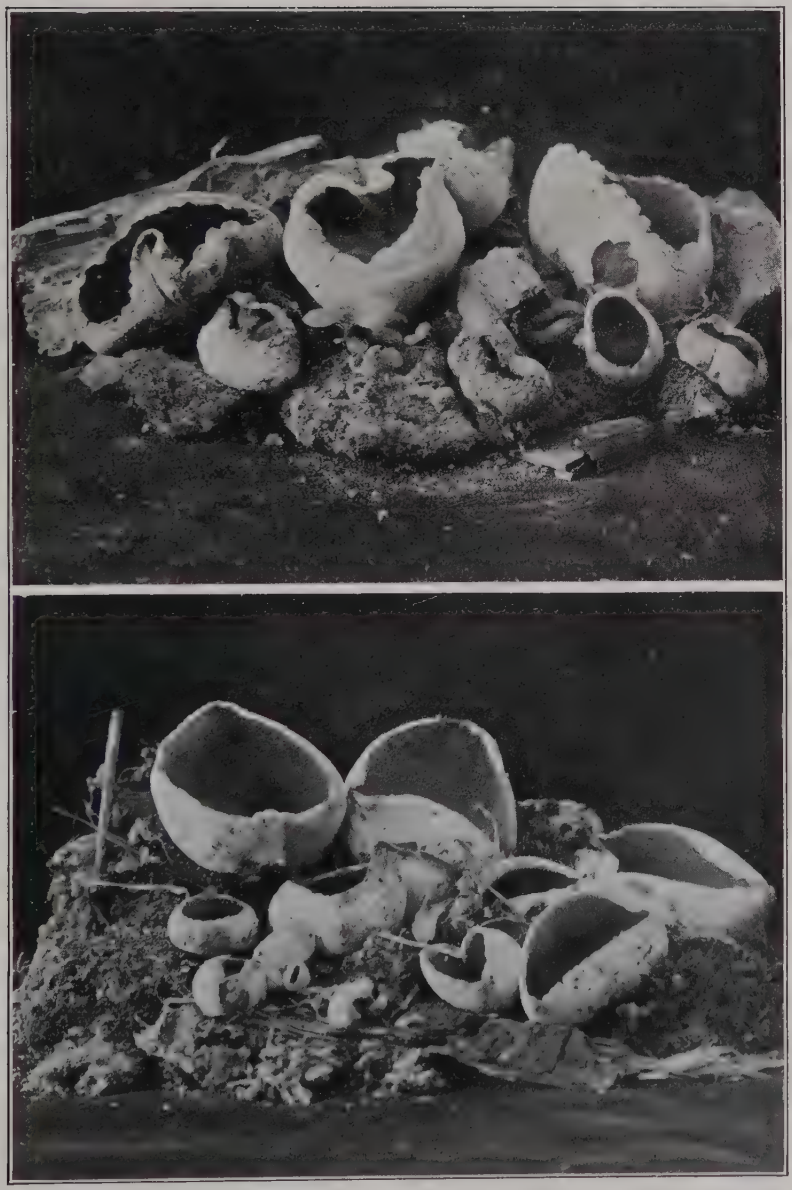
PLATE CLV

Upper figure, *Peziza vesiculosa* Bull.
Lower figure, *Peziza badia* Pers.

PLATE CLVI

Upper figure, *Peziza pustulata* (Hedw.) Pers.
Lower figure, *Peziza sylvestris* (Boud.) Seaver.

PEZIZA VESICULOSA BULL.
PEZIZA BADIA PERS.



PEZIZA PUSTULATA (HEDW.) PERS.
PEZIZA SYLVESTRIS (BOUD.) SEAVER

No 37.

Photographs

ILLUSTRATIONS AND DESCRIPTIONS OF CUP-FUNGI—II. SEPULTARIA

Fred J. Seaver

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ILLUSTRATIONS AND DESCRIPTIONS OF CUP-FUNGI—II. SEPULTARIA

FRED J. SEAVER

(WITH PLATE 161, CONTAINING 3 FIGURES)

The genus *Sepultaria* was founded by Massee,[1] the name having been first used by Cooke for a subgenus of *Peziza*. The genus was based on *Peziza sepulta* Fries,[2] one of the few species of true hypogaeous cup-fungi.

Previous to the publication of *Peziza sepulta* by Fries, Léveillé[3] described a species with similar characters under the name of *Peziza arenicola*. According to Léveillé, the latter species is peculiar in its mode of development, since the apothecia are at first subglobose and entirely concealed in the ground. After abundant rains they open and then for the first time become visible. The outer surface is covered with long fine hairs which bind the sand to the outside of the apothecia so closely that it is not easily detached.

According to Berkeley and Broome who published Fries's manuscript name of *Peziza sepulta*, this species is closely related to *Peziza arenicola* Lév. and also has a close resemblance to *Hydnocystis* Tul. The plants of the latter genus are said by Tulasne not to open to the surface and in this respect only they differ from those of *Sepultaria*. *Hydnocystis* is commonly placed among the Tuberales.

The writer has examined a specimen of *Peziza arenicola* Lév. from Léveillé and also a specimen of *Peziza sepulta* Fries from Scandinavia and find that the two are identical.

What appears to be the same species has been frequently collected by Professor Ellsworth Bethel in the vicinity of Denver, Colorado. He writes that the fungus is entirely submerged with

[1] Massee, Brit. Fungus Fl. 4: 389. 1895.
[2] Ann. Mag. Nat. Hist. II. 13: 463. 1854.
[3] Ann. Sci. Nat. III. 9: 140. 1848.

them and is frequently collected by his students who know it as the *"hole in the ground,"* since they find it by looking for holes in the sandy soil. Mr. Ellis was at first inclined to regard the Colorado plants as a new species but finally came to the conclusion that the species was identical with *Peziza sepulta* Fries, according to notes in the Ellis Collection.

The writer has recently received from Mr. W. H. Long in New Mexico fine specimens of a *Sepultaria* which closely resembles the species so frequently collected by Bethel in Colorado. According to the collector, the New Mexican plants do not protrude above ground at all in any of the thirty or forty specimens collected, although the soil is said to be slightly raised when the apothecia break. When mature, small cracks appear in the tops of the apothecia which if the soil is not too firm around them will expand and finally expose some of the hymenium. The New Mexican material was shipped fresh and was received in excellent condition. From some of this material the accompanying photographs were made.

While the New Mexican plants are closely related to *Sepultaria arenicola* (Lév.) Massee, they seem to differ in the form of the spores which are ellipsoid but only slightly longer than broad, while those of the former are often twice as long as broad. Aside from this, the New Mexican plants appear to differ in general habits. Gross characters, however, such as congested habit are taken with considerable allowance since the writer has had no opportunity to make a study of the Colorado plants in a fresh condition and the New Mexican plants are known only from the specimens described here. From the studies which have been made, the New Mexican plants are regarded as distinct.

Specimens which have been referred to *Sepultaria arenicola* (Lév.) Massee, have occasionally been collected in different parts of the east, although the species seems like the one here described to be characteristic of the dry plains of the west. A number of other species have been referred to the genus which are smaller and only partially buried. So far as known, the genus at present contains five species for North America, including the one here described.

SEPULTARIA LONGII SEAVER

The genus should not be confused, as has often been done, with *Sarcosphaera* which differs from *Sepultaria* in the absence of the long brown hairs which are so characteristic of the plants of the latter genus. The two genera agree in that both are hypogaeous. So far as habits are concerned, *Sepultaria* seems to be intermediate between the Pezizales and the Tuberales although with the exception of *Hydnocystis* the fruit characters are not nearly so suggestive of the Tuberales as are those of some other discomycete genera such as *Boudiera* and *Lamprospora*. However that is a question for the morphologist.

Sepultaria Longii sp. nov.

Apothecia densely gregarious or cespitose, at first closed and entirely buried, finally opening to the surface by an elongated or compressed aperture, or when the substratum is not too compact spreading so as to expose the hymenium, never protruding above the surface of the substratum but causing the soil to become slightly elevated as they mature, reaching a diameter of 4 cm., regular in form or becoming very much contorted from mutual pressure, externally pale-brown and entirely clothed with long hairs which extend into the substratum, binding the surrounding soil closely to the outside of the apothecium; hairs flexuous, septate, brown, and of nearly uniform thickness throughout their entire length; asci subcylindric above, tapering gradually below into a stem-like base, reaching a length of 250–300 μ and a diameter of 20–22 μ; spores 1-seriate, short-ellipsoid or subglobose, at first containing one small oil-drop which gradually enlarges until it nearly fills the spore, about 18–20 $\times$ 20–22 μ; paraphyses stout, gradually enlarged above where they reach a diameter of 4–6 μ, filled with numerous vacuoles or oil-drops, hyaline.

On bare ground.

TYPE LOCALITY: Albuquerque, New Mexico.

DISTRIBUTION: Known only from the type locality.

EXPLANATION OF PLATE CLXI

Upper figure, group of apothecia partially concealed by the soil; middle figure, section through the cluster of apothecia showing their hypogaeous habit; lower figure, several apothecia removed from the soil.

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OBSERVATIONS ON HERPOTRICHIA NIGRA AND ASSOCIATED SPECIES

FRED J. SEAVER

Several years ago while attempting to work out the identity of *Herpotrichia nigra* Hartig and *Neopeckia Coulteri* (Peck) Sacc., the writer was surprised to find the ascospores of a third species on *Picea* which was at first thought to be an undescribed species of *Herpotrichia*. The spores of this species were fusiform, long and narrower than those of *Herpotrichia nigra* and, while usually 5-septate, were often 6-septate and occasionally even 7-septate, while those of *Herpotrichia* nigra were broad, blunt and never more than 3-septate so far as observed.

This strange species was first detected while studying Ellis & Everhart's Fungi Columbiani *1737*, a specimen of *Herpotrichia nigra* which was erroneously distributed under the name of *Lasiosphaeria Coulteri*. The spores of this species were again observed while examining a specimen of *Herpotrichia nigra* on *Picea Engelmanni* sent from Colorado by Bethel, July 7, 1914.

After a careful study it was found that these fusiform spores were not the spores of a *Herpotrichia* as at first suspected but were those of a *Mytilidion* which has been repeatedly found on conifers associated with *Herpotrichia nigra*. The genus *Mytilidion* belongs to the Hysteriales and the perithecia of the plants of this genus are laterally compressed and closely resemble a miniature clam or other bivalve, opening by a slit across the top of the perithecium and very different from the subglobose perithecia of *Herpotrichia*. The perithecia of the *Mytilidion* are, however, so intimately associated with those of the *Herpotrichia* that their real characters may be easily overlooked and when removed together, the spores of the *Mytilidion* may be mistaken for the mature spores of the *Herpotrichia*. If, however, the perithecia are removed and studied individually, it will be found that the fusiform spores are always obtained from the hysteriform perithecia while the subglobose perithecia contain the 3-septate spores which are characteristic of *Herpotrichia nigra*.

The *Mytilidion* is closely related to, if not identical with *Mytilidion fusisporum* (Cooke) Sacc., a species which has been reported on branches and bark of spruces and firs. Cooke's species is said to have spores 50 μ long, while the spores of our species have never been found to exceed 40 μ and are often not more than 30 μ. Having seen no authentic specimen of Cooke's species, it is impossible to know how much importance to attach to this apparent difference in the size of the spores. Our specimens have been doubtfully referred to that species.

The recent appearance of the description of a new species of *Herpotrichia* by Weir in the *Journal of Agricultural Research* has attracted the attention of the writer since the spores of his species were practically identical in size and form with those of the *Mytilidion* which has been so frequently found associated with *Herpotrichia nigra*. From the facts in hand the writer is inclined to believe that Weir's supposed new species is based on the combined characters of two different plants, the mycelial and perithecial characters being those of the well-known *Herpotrichia nigra* while the ascus and spore characters are those of the *Mytilidion*.

This suspicion has been strengthened by recent studies of our collections of *Herpotrichia nigra* which shows practically every specimen examined to be accompanied by the *Mytilidion*, the abundance of the latter species varying considerably in different specimens. To add to the difficulty the perithecia of the *Mytilidion* are often overrun by the mycelium of the *Herpotrichia* so that the perithecial characters are obscured. Not only has the *Mytilidion* been found on spruce needles associated with *Herpotrichia*, but it has also been found on pine needles associated in the same way with *Neopeckia Coulteri*.

Weir's drawings illustrate very well the spore characters of the three species, *Neopeckia Coulteri*, *Herpotrichia nigra* and the unnamed species of *Mytilidion* except that the spores of the last are not always 5-septate as indicated in his drawings but are often 6-septate and occasionally even 7-septate. The spore measurements are usually within the limits given by Weir, but spores are occasionally found as long as 38–40 μ. The color is pale-brown, as indicated by him.

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